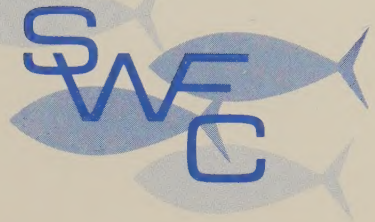


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SOUTHWEST FISHERIES CENTER

REPORT OF ACTIVITIES SEPTEMBER-OCTOBER 1986

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COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

Mexican Fisheries Officials Attend CalCOFI Conference

A featured speaker at the annual California Cooperative Oceanic Fisheries Investigations (CalCOFI) Conference at Lake Arrowhead, California, October 21-23, was Dr. Alfredo Laguarda, newly-designated Director-General, Instituto Nacional de la Pesca, Secretaria de Pesca, Mexico City, who called for renewed cooperation between Mexico and the U.S. on studies of fish of mutual interest to both countries.

CalCOFI, a research umbrella for scientists from the NMFS Southwest Fisheries Center, University of California's Scripps Institution of Oceanography, and the California Department of Fish and Game, meets annually to present papers on the status of current research on important commercial fishes such as sardines, anchovy, and mackerel. Scientists from other countries working on these species are also invited to present the results of their research.

The topic of this year's symposium, the present and future of Mexican fisheries science, attracted a number of participating Mexican fisheries scientists and top officials of the Instituto Nacional de la Pesca. During the symposium, Dr. Laguarda presented an overview of fisheries research at the Instituto and discussed a general plan for its future development.

The presence of the Mexican fisheries officials at the Conference was particularly fortuitous from the standpoint of improving the climate between Mexico and the U.S. for future cooperative fisheries research. As an example of the cordial relations which developed was the suggestion of Dr. Laguarda that the Mexicans assign either of their research vessels, Puma or Humboldt, to undertake the anchovy biomass assessment as the sole ship involved, most probably in 1988.

Six scientists from the Southwest Fisheries Center gave presentations at CalCOFI on topics ranging from rates of euphausiid predation on larval anchovy to revised historical abundance estimates of the Pacific mackerel spawning biomass. (R. Lasker, FTS 893-6212)

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COASTAL EASTERN PACIFIC POPULATION BIOLOGY OF FISHES

Reproduction and Water Content of Dover Sole Studied

For studies designed to evaluate the egg production method for biomass assessment of the slope groundfish Dover sole and sablefish, Fishery Biologist John Hunter conducted a preliminary analysis of Dover sole reproduction. He obtained live specimens and maintained them in the laboratory for work on reproduction and egg development rates (Figure 1). Dover sole were taken monthly from December 1985 to May 1986, except for April, in the area from Monterey to Point Conception, California. Among those participating in this research were Biological Technicians Beverly Macewicz, Eric Lynn, and Carol Kimbrell and Fishery Biologist Roger Leong. Analyses have now been completed for maturity, water content, and other aspects of reproduction.



Figure 1. Two members of Dover sole brood stock shown in their feeding posture.

Based on preliminary conclusions, they found that the total length (mm) at which 50% of female Dover sole attained sexual maturity was 311 mm when only December collections were included, but the length was 349 mm when collections from December through May were considered. Larger size at first maturity is obtained using all collections because at some time after the cessation of spawning an immature ovary cannot be distinguished histologically from an inactive one. This bias may explain the larger size at

maturity (363 mm) determined for the Eureka California fishery in a 1952 study by Hagerman who presumably used females from all spawning months. These differences in length are important. A 360 mm Dover sole is about 10 years old, whereas a 311 mm female is between 7 and 8.

The average total length of Dover sole taken in a research trawl (December-May) increased with depth (Figure 2). Fish size increased sharply over 100-300 fathoms but remained more or less constant at greater depths. No fish taken at 100 fathoms were mature and only 40% of those taken at 200 fathoms were mature but all fish taken at 300 fathoms and greater depths were mature. Maturity was more strongly correlated with female length than with depth, however.

For the Dover sole, water content of both red and white muscle increased with length of the fish and depth of capture (Figure 2). However, the water content was more strongly correlated with female size than with depth; the relation to depth was probably solely a function of the relation between depth and length already mentioned. In a separate study these changes in water content have been linked to resorption of muscle proteins. There were fewer changes in water content in red muscle than the white, indicating that red muscle is conserved. Red muscle is used for control of head movements during feeding.

Eight percent of the Dover sole taken in December 1985 were in postspawning condition, indicating that spawning was well underway by December. Only 5% of the females taken in March and 12% in May had active ovaries and few batches of advanced oocytes remained in the ovaries of these females. These data indicate that the peak spawning months were December, January and February, although a minor fraction of the population continues to spawn as late as May.

No females with a full batch of hydrated eggs were taken in the collections. Consequently, an accurate estimate of batch fecundity was not possible. However, two females from California

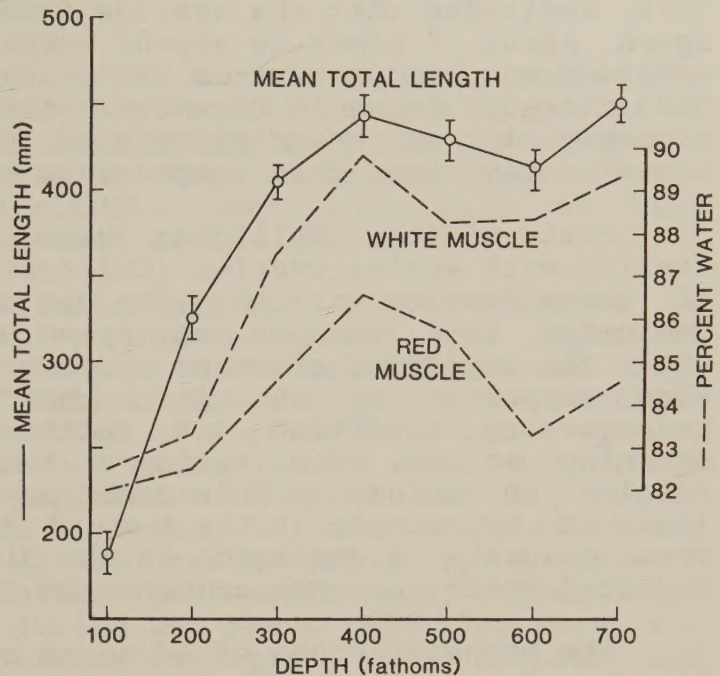


Figure 2. The relation between total length of Dover sole (means $\pm 2 \times$ standard error of mean); mean water content of white and red muscle, and depth (fathoms).

taken in a previous year and five from the Oregon coast in 1986 (material provided by M. Yoklavich and E. Pikitch) were analyzed. The mean relative batch fecundity (batch fecundity/female weight) for these 7 females was 13.5 eggs per gram with SD = 5.5. The standing stock of advanced oocytes for females taken off Oregon by Yoklavich and Pikitch (ms) was about 100 eggs/g female weight. This indicates that the average female Dover sole would have to spawn about 7 times to expend completely the standing stock of advanced oocytes present in the ovary in December. As spawning had already begun in December, the standing stock of oocytes probably is an underestimate of potential annual fecundity; consequently, more than 7 spawnings seems likely.

Postovulatory follicles were observed in about half the females with active ovaries (California collections) and in many of these females more than one age of follicle were seen. This indicates that females may spawn batches in rapid succession until the supply of advanced oocytes is exhausted. This view is also supported by the fact that females with ovaries in postspawning condition are relatively common throughout the spawning season. The rarity of females in the hydrated state remains an enigma. This could be the result of sampling bias (failure to sample at the time of day and depth at which this event occurs), a contagion in the distribution of females in the hydrated state, or some combination of these variables.

The standing stock of advanced oocytes before first spawning may be an accurate estimate of potential annual fecundity. The evidence is: 1) a distinct hiatus in oocyte maturity classes usually existed between the small, immature unyolked oocytes and the maturing and advanced yolked oocytes; and 2) the preliminary data indicate that the standing stock of advanced oocytes declines over the season. The possibility that some females may produce more than one stock of advanced eggs per season cannot be ruled out at this time, however. As this is a critical conclusion for estimating spawning biomass using the Egg Production Method, further research on this topic is underway.

Preliminary data on atretic condition of ovaries indicate that the potential annual fecundity (standing stock of advanced oocytes prior to first spawning) is probably close but slightly lower than the realized annual fecundity.

Work currently underway or planned will provide better estimates of batch fecundity, estimates of potential annual fecundity, rates of spawning, and a calibration between water content and total calories for Dover sole. Intensive work on reproduction of sablefish is also planned for this fiscal year. (J. Hunter, FTS 893-6220)

ECOLOGY AND TAXONOMY OF FISHES, CalCOFI

Progress Made in Species Identification of Flatfish Larvae of the Genera Citharichthys and Etropus in CalCOFI Samples

Fishery Biologist Barbara Sumida MacCall recently worked out the taxonomic problem of differentiating larvae of six species of Citharichthys and larvae of Etropus crossotus. She presented the results in a poster at the California Cooperative Oceanic Fisheries Investigations (CalCOFI) conference held at Lake Arrowhead, California, from October 21-23, 1986.

Larvae of sanddabs, Citharichthys spp., are abundant in CalCOFI ichthyoplankton samples and the adults are important members of coastal bottom communities off California and Baja California. Seven species of Citharichthys occur in the sampling region along with a single species of a closely related genus, Etropus. Only three species of sanddabs have been identified routinely in CalCOFI ichthyoplankton samples and a recent comprehensive study revealed that many of the identifications were incorrect. As part of the current effort to develop a computer data base for the CalCOFI ichthyoplankton collections, all sanddab larvae collected during the years 1954-1960 were re-identified by MacCall and Fishery Biologists David Ambrose and Betsy Stevens, and Biological Technician Elaine Sandknop Acuna.

Larvae of six of the seven sanddab species found in the CalCOFI region can be identified by their morphological features, meristic and gill-raker counts, and pigmentation. The species fall into 3 categories based on the development of early-forming elongate dorsal fin rays--C. platophrys forms 3 elongate rays, C. fragilis, C. gordae, C. sordidus, and C. xanthostigma form 2 rays, and C. stigmaeus lacks elongate rays. Etropus crossotus forms 2 elongate rays. Etropus crossotus, C. gordae and C. platophrys occur in the southern region of the CalCOFI sampling pattern and each is easily recognized by a deep body form in combination with a unique pattern of pigmentation. Larvae of C. fragilis, C. sordidus, and C. xanthostigma are similar but may be distinguished by a combination of characters that includes: size at various stages of development, body form, meristics (in larger specimens) and pigmentation. Key pigmentation characters include: the position of the pigment band on the tail, the number and pattern of serial melanophores on the ventral midline of the tail, and the arrangement of pigment at the tip of the notochord. (B. Sumida MacCall, FTS 893-6215)

Computer Data Base Developed for Historical CalCOFI Ichthyoplankton Collections

The California Cooperative Oceanic Fisheries Investigations (CalCOFI) ichthyoplankton collections span a period of 36 years,

beginning in 1949, with synoptic sampling using oblique tows for 28 of those years. Annual surveys consisted of monthly cruises in the 1950s and either monthly or quarterly cruises during the 1960s. After 1969 the surveys were triennial (1972, 1975, 1978, 1981, 1984) or annual (1985, 1986) with either monthly or quarterly coverage. Despite reduction of the survey area and cruise frequency over the span of the program, these collections represent the most extensive and complete ichthyoplankton time series ever assembled. Richard Charter, Leader of the Coastal and Pacific Fisheries Investigations; Dr. Geoffrey Moser, Leader of the Ecology and Systematics of Fishes; and Dr. Paul Smith, Leader of the Survey Systems Development and Evaluation, have been working to develop a computer data base for the historical CalCOFI ichthyoplankton collections.

At the beginning of the CalCOFI program the Pacific sardine (Sardinops sagax) and the northern anchovy (Engraulis mordax) were of primary interest and all larvae of these species were identified and measured during the plankton sorting process. Sardine eggs were identified and staged. Larvae of Pacific whiting (Merluccius productus) and rockfishes (Sebastes spp.) were counted but not measured. Length frequencies were recorded for jack mackerel (Trachurus symmetricus) beginning in 1952 and for chub mackerel (Scomber japonicus) in 1953. These records for the years 1950-59 were published in a series of 9 data reports and a computer data base for these and subsequent years was established in 1969.

The taxa listed above represent a small fraction of the total taxa taken in CalCOFI plankton tows. After the plankton were sorted, unidentified fish larvae were examined and identified to the lowest taxon possible. Initially, about 75 taxa were distinguished, with 36 identified to species, 14 to genus, 20 to family and 5 to order. A continuing research program over the past 35 years has increased the total number of taxa identified to about 221 (about 129 identified to species, 47 to genus, 40 to family and 5 to order). The development of the CalCOFI ichthyoplankton data set has proceeded slowly because of the large size of the samples, their taxonomic complexity, and the inherent difficulty in identifying ontogenetic stages. The lack of a computer data base for these samples has limited their utility; increasing interest in this time series stemming from fisheries diversification and ecological/community studies has intensified this need.

In 1983 resources were provided to establish a CalCOFI data base and completion is scheduled for December 1987. The task of checking accuracy of identifications made over a period of increasing knowledge and competency is particularly difficult. The approach has been to find geographic, seasonal and statistical outliers in the data set and check these by the laborious process of examining archival specimens. During this process numerous unsuspected identification errors were discovered and eventually all taxa were scrutinized. Many groups were completely re-identified. Tow and station data were checked

and corrected for all CalCOFI stations. When this project is completed there will be a reliable data base for the historical CalCOFI ichthyoplankton program. These data will be accessible to investigators through a series of data reports that accompany and complement the computer data base services. Staff members of the Ecology and Systematics of Fishes Task who made the ichthyoplankton identifications and data checks will serve as senior authors of the data reports. They are Fishery Biologists David Ambrose, Barbara Sumida MacCall, Elizabeth Stevens, and Biological Technician Elaine Sandknop Acuna. Other key contributors to this project are Computer Programmers Cindy Meyer and Larry Zins, Biological Technician Debby Snow, Biological Aids Brad Earhart, Celeste Methot, and Jim Ryan. (R. Charter, FTS 893-6340; G. Moser, FTS 893-6239; P. Smith, FTS 893-6346)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Analysis Made of Multispecies Catch Patterns in Sablefish Trawl Fleet

When monitoring or analyzing the economic performance of a large number of fishing vessels, it is often desirable to aggregate vessels into representative sub-fleets or vessel categories. Such classification practices are intended to establish groups comprising vessels that can be treated the same and that can be expected to act the same. Frequently, the procedures for classifying vessels are ad hoc in nature--vessel groups are typically partitioned according to criteria relating to physical characteristics (e.g. vessel length). Although this method is statistically convenient, it may not satisfactorily distinguish between vessels fishing in markedly disparate segments of the multispecies fishery. Classification along operational or performance lines is of particular concern when dealing with multi-species or multi-purpose vessels, especially when such vessels' operations are constrained by management regulations.

A study being conducted by Industry Economist Sam Herrick addresses these vessel classification concerns. In the study, he uses clustering techniques to analyze the annual landings and vessel characteristics data for U.S. vessels that harvested sablefish from the west coast Fishery Conservation Zone during 1984. The analysis attempts to identify particular fishing modes that are characterized by the types of gear and the combinations of species landed.

One case examines the annual landings of only those vessels having trawl gear as the primary gear (the gear that accounts for a plurality of the vessel's landings revenue) that landed at least 200 tons of trawl species in 1984, that are no greater than 100 feet in length, and that did not harvest fish from the Puget

Sound area during 1984. The resulting 131 vessels were clustered across their annual landings by species to derive landings clusters represented by the final cluster centers shown in Table 1.

Table 1. Final cluster centers for trawl vessels clustered across annual landings in 1984 (N = number of vessels assigned to each cluster).

Species	Cluster				
	1.(N=34)	2.(N=16)	3.(N=7)	4.(N=3)	5.(N=71)
	(Average annual landings, short tons)				
Dover sole	249.6	22.5	36.7	26.0	76.6
Other flatfish	24.6	9.8	9.9	2.4	25.0
Widow rockfish	5.7	201.4	23.9	276.1	9.1
Other rockfish	61.2	185.7	585.1	21.3	102.2
Sablefish	82.1	15.3	35.2	20.1	33.8
Pacific whiting	.1	1.6	2.7	346.4	.7
Pac. ocean perch	7.7	23.6	3.0	6.2	12.7
Cod	68.6	13.4	25.9	9.3	22.2
Pink shrimp	.2	.2	.0	.0	15.0
Dungeness crab	2.2	.5	.0	.0	2.1
Miscellaneous	2.7	.1	1.7	3.7	1.2

The final cluster centers are defined by the average annual landings of each species for the vessels assigned to that cluster. The results indicate that the majority of vessels tend to be quite diverse in their fishing operations as shown by the presence of all species in their annual landings. The vessels assigned to other clusters are characterized by annual landings that are dominated by one or two species.

The clustering results also show that vessels that group together on the basis of similar performance may not be in the same group that is formed according to preestablished classification criteria, in this instance length. Table 2 presents the results from a cross-tabulation of vessel length with cluster membership for the 131 trawl vessels described above. The results, particularly the chi-square test for independence, suggest that across vessels, performance is unrelated to vessel length. Therefore, it is not always appropriate to assume that vessels which are alike in their physical design are also similar with respect to their patterns of operation and performance.

Table 2. Results from cross-tabulating vessel length with vessel landings cluster membership.

Length class	Cluster membership				
	1	2	3	4	5
1-49 ft	5				14
50-74 ft	27	13	6	3	55
75 ft and greater	2	3	1		2

CHI-SQUARE DEGREES OF FREEDOM SIGNIFICANCE

11.738

8

0.1633

The preliminary findings have produced some rather interesting results about fishing operations and performance. Some rather distinct patterns of quantities landed by species emerge within groups of vessels having the same primary gear. This is useful information for fishery managers and policy makers who make decisions that are likely to affect the fishery alternatives available to these vessels. (S. Herrick, FTS 893-6222)

Data from Bases Project Delivered by Contractor

Cynthia Thomson, Industry Economist, reports that CIC Research, Inc. has delivered the Bay Area Sportfish Economic Survey (BASES) data collected covering recreational fishing during July 1985 to June 1986. These data will be analyzed during the next three months to estimate economic values and to test alternative models of angler demand. The data were collected in six, 2-month survey periods. A total of 1,378 questionnaire forms was completed by randomly selected households. The number of respondents varied for each survey period.

Thomson and Program Leader Daniel Huppert are compiling summary data for a report on the survey effort. Data to be reported include levels of avidity, angler assessment of skill, income class, county of residence, numbers of fishing trips taken in the most recent two-month and twelve-month period, distance from fishing sites, modes of fishing, species targeted and numbers caught. (C. Thomson, FTS 893-6225)

Production Analysis of Trawl Fishing Completed

Dale Squires, Industry Economist, recently completed a statistical analysis of relationships between capital, labor, and fuel use in the multipurpose Pacific trawl fleet. The results from this study can be used to help plan more effective fishery management for the fleet. For example, if limitations were eventually placed on the number of vessels in the fleet, increased investment in individual vessel harvesting capability could negate the capacity-reducing effects of limiting the number of participants. This study provides information on the technological capacity for increased capitalization and it can be used in planning a limited entry program.

The empirical results suggest that the technological constraints to capital expansion are not particularly binding. Thus, expansion of individual vessel productive capacity could easily occur under a license limitation program, and an effective limited entry program might limit more than simply the number of vessels in the fleet. Alternatively, should the current management program change from trip limits to individual species quotas tied to some measure of potential harvest capacity such as the number of crew members, sizeable expansions in this input to allow increased catches are possible. (D. Squires, FTS 893-6309)

Maturation in Anchovy Studied

Richard Methot, Fishery Biologist, has been working on a description of the fraction of young anchovy that are spawning. This fraction is important to the dynamics of the population and to stock assessment because it determines the relation between total abundance and measured spawning biomass. In a previous study, Richard Parrish and Donna Mallicoate of the Pacific Fisheries Environmental Group and Richard Klingbeil of the California Department of Fish and Game combined all fishery and trawl survey data from 1966 to 1982, and described a seasonal pattern in fraction spawning and egg production for each age class. Methot analyzed the same trawl data, using only surveys conducted in the period between late January to early March, and found a strong relation between water temperature and the fraction of spawning for age 1 fish. In cold years, 13.0°C, only about 15% of the age 1 anchovy were actively spawning; in warm years, 16.0°C, 85% were actively spawning. Methot presented this result at the California Cooperative Oceanic Fisheries Investigations Conference at Lake Arrowhead in October 1986.

Currently, Methot is working on a more precise description of the effects of temperature on spawning activity by including in the analysis the time of year when the cruise took place. The preliminary result is that within the period between late January to early March and the temperature range of 14.5-15.5°C, the exact time of sampling is important. In this temperature range, about 90% of the age 1 anchovy collected after February 15 are

spawning, and less than 20% collected before February 5 are spawning. Methot hopes to describe this pattern by modeling fraction spawning as a logistic function of both temperature and date.

Methot also has initiated an analysis of the fishery data to describe interannual variability in spawning by young anchovy. These data are most valuable prior to 1977, a cold period in which the sample sizes in trawl surveys were small. Parrish, Mallicoate, and Klingbeil noted that the fishery tends to collect larger fish, so the mean level of spawning by age 1 fish tends to be greater in fishery samples than in trawl samples. Preliminary examination of the fishery data indicates that about 90% of the age 1 anchovy were spawning in January-March of most years, but less than 20% were spawning in the cold years of 1972, 1974, and 1976. Also, in 1972 and 1974, only about 50% of the age 2 anchovy were spawning.

In his work on an age-structured description of historical anchovy abundance, Methot has noted that observed egg abundance in 1972 was much lower than expected, even after accounting for low spawning by age 1 fish in that cold year. Including the new description of the low level of spawning by age 2 anchovy in 1972 data will help resolve this discrepancy. (R. Methot, FTS 893-6221)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

FISHERY INDEPENDENT DATA

Document on Biological Factors Affecting the Recovery of Gulf of California Harbor Porpoise Prepared

When the Gulf of California harbor porpoise, Phocoena sinus, was listed as an endangered species under U.S. laws, Congress requested the National Marine Fisheries Service to review information regarding the species and consider factors influencing or promoting its recovery. Operations Research Analyst Jay Barlow has now prepared a document on the Gulf of California harbor porpoise, which is under final review. In this report, Barlow reviews the available biological information on P. sinus, comments on the weaknesses and gaps in current knowledge, and makes suggestions for filling these gaps. A summary of the text is provided below.

The Gulf of California harbor porpoise has one of the most limited ranges of any marine mammal. This species appears to be limited to the northern regions of the Gulf of California, where it is known locally as vaquita. Only 29 confirmed sightings have been made since the original species description in 1958. The lower limit on the population size for this species may be as low as 50-100 animals. The species is vulnerable to incidental mortality in commercial fishery operations, and therefore, given the small population size, is vulnerable to depletion and possible extinction.

Little is known about reproduction in P. sinus. A related species, P. phocoena, apparently matures between 3 and 5 years of age. The average reproductive interval for this species is thought to be between 1 and 2 years. Very little is known about natural mortality rates. Most researchers have agreed that these animals are relatively shorter lived than delphinid cetaceans, and that maximum longevity is between 13-15 years. Therefore, the maximum rate of population growth is thought to be less than 10% per year.

Given the limited range of P. sinus, habitat quality may play a major role in determining whether recovery is possible and how rapidly it may occur. Habitat degradation may take the form of organic pollutants, reduced productivity due to the reduction of fresh water and nutrients from the Colorado River, reductions in food supplies due to commercial fishing operations, or catastrophic accidents such as a large oil spill.

At this time, the survival of P. sinus is not certain. If recovery occurs, it will be slow. Information on distribution, fishing mortality, and reproduction is needed to maximize the probability of successfully managing this species. (J. Barlow, FTS 893-6263)

Stock of Northern Elephant Seals Assessed

Operations Research Analyst Peter Boveng, Wildlife Biologist Douglas DeMaster, and Field Biologist Brent Stewart of Hubbs Marine Research Institute have applied a new method, called dynamic response analysis, for assessing the status of the northern elephant seal stock. The primary aim of marine mammal stock assessment is to determine the status of the stock or population relative to the size of the population at which its growth rate would be maximal. This critical population size, called the maximum net productivity level (MNPL), is the lower end of a range of population sizes considered to be optimum sustainable population sizes (based on the wording of the U.S. Marine Mammal Protection Act).

For a species such as the northern elephant seal (which is recovering from past vigorous exploitation but is not currently subject to an appreciable harvest), the MNPL occurs at the inflection point below which population size plotted against time will curve upward and above which the curvature is downward (though the population may still be increasing). Dynamic response analysis (DRA) uses this qualitative observation to determine the status of the population by statistical analysis of the direction of curvature based on a set of recent censuses.

The direction of curvature in an interval of censuses can be determined by a second degree polynomial regression using population size as a function of time. Then the sign of the second order regression coefficient will indicate the direction of curvature (positive is up). If a population were growing according to the well known logistic model of density-dependent growth, and the second order regression coefficients from several census intervals were plotted against the time at the midpoints of the intervals, the resulting curves would look like those in Figure 1. The error bars in Figure 1 indicate the "lack of fit" error introduced by fitting a logistic curve to a quadratic model, but the effect diminishes rapidly with moderate increases in number of censuses per interval. Populations growing by density-dependent processes other than those which result in logistic growth would produce curves with slightly different shapes than those in Figure 1, but the feature of only crossing the zero line once (when the population passes MNPL) would be preserved. When the technique is applied to real population data, inconsistency with that general feature is interpreted to mean that the length of the census interval is too short, which confounds curvature due simply to "noise" with curvature due to density dependence. The minimum number of censuses which

generates a plot which is not inconsistent with those in Figure 1 is used for the actual dynamic response analysis (interval length is minimized in an effort to base the assessment on information which is as current as possible).

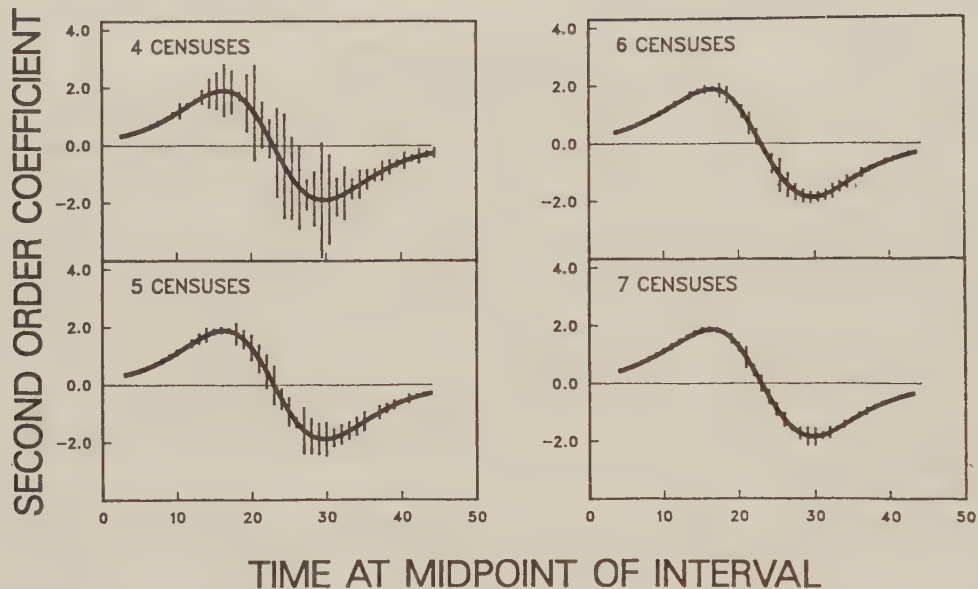


Figure 1. Second order regression coefficients (± 2 std. errors) computed from intervals of various lengths in a logistic population trajectory, with $r=.20$, initial $N=10$, and $K=1000$.

These techniques, which have been described in a manuscript submitted to Marine Mammal Science, have been applied to several colonies of northern elephant seals. The plots of second order regression coefficients generated from counts of pups (which can be used as an index of population size for DRA) on the San Miguel Island colony prior to 1982 are shown in Figure 2. Interval lengths shorter than 8 censuses produce curves which are not significantly (± 2 standard errors) different from zero at several points along the curves. When 8 or more censuses per interval are used, the curves are similar to the left tails of those in Figure 1, suggesting that an interval of 8 censuses is sufficient, for the San Miguel colony, to detect density dependent curvature in the trajectory. Furthermore, the second order coefficient from the regression on the 8 pup counts made between 1975 and 1982 (most recent censuses available at the time of the analysis) is positive ($b=51.8$, $s.e.=24.4$), indicating that the colony's growth during those years was like that of a population below its MNPL.

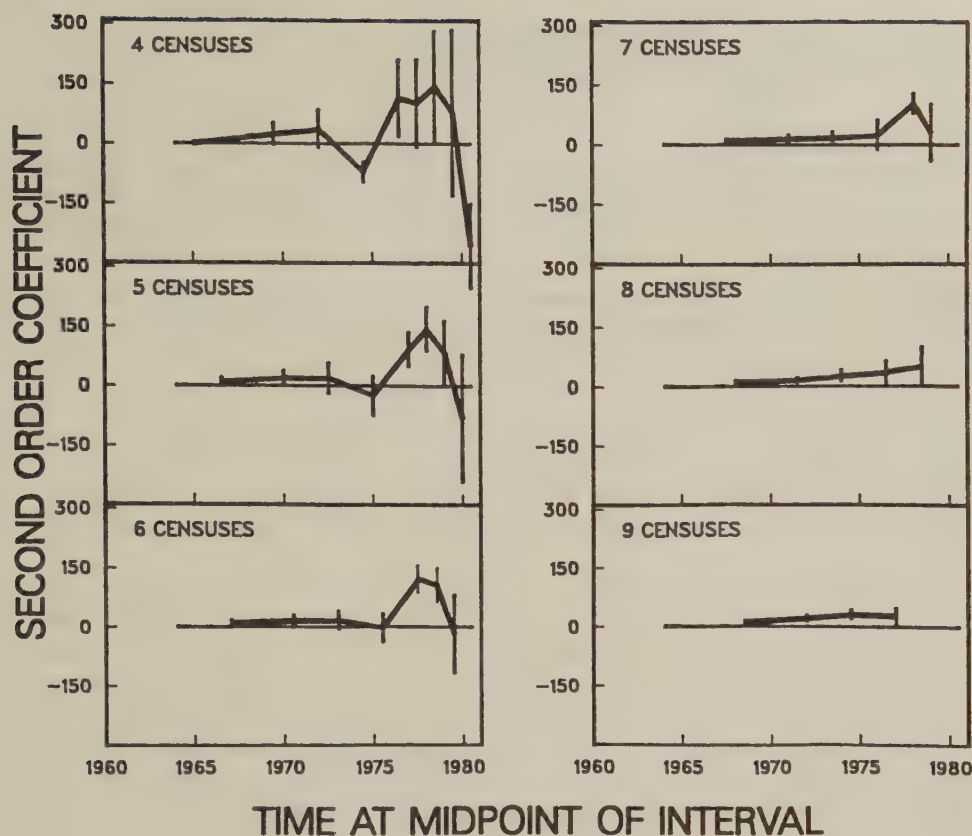


Figure 2. Second order regression coefficients (± 2 std. errors) computed from intervals of various lengths in the trajectory of elephant seal pup counts on San Miguel Island.

This "local" analysis of the shape of a population growth curve allows the status of a population to be determined on the basis of recent information and avoids the need for detailed historical harvest records or pre-exploitation population size. For the current population assessment, the DRA will be extended to include data collected more recently than 1982, and at least three other colonies (South Farallons, Ano Nuevo, San Nicolas) will be included as well.

The results of the assessments will be used by the Southwest Region in considering renewal of general permits to coastal fishing organizations. The current permits expire at the end of calendar year 1988. (P. Boveng, FTS 893-6345)

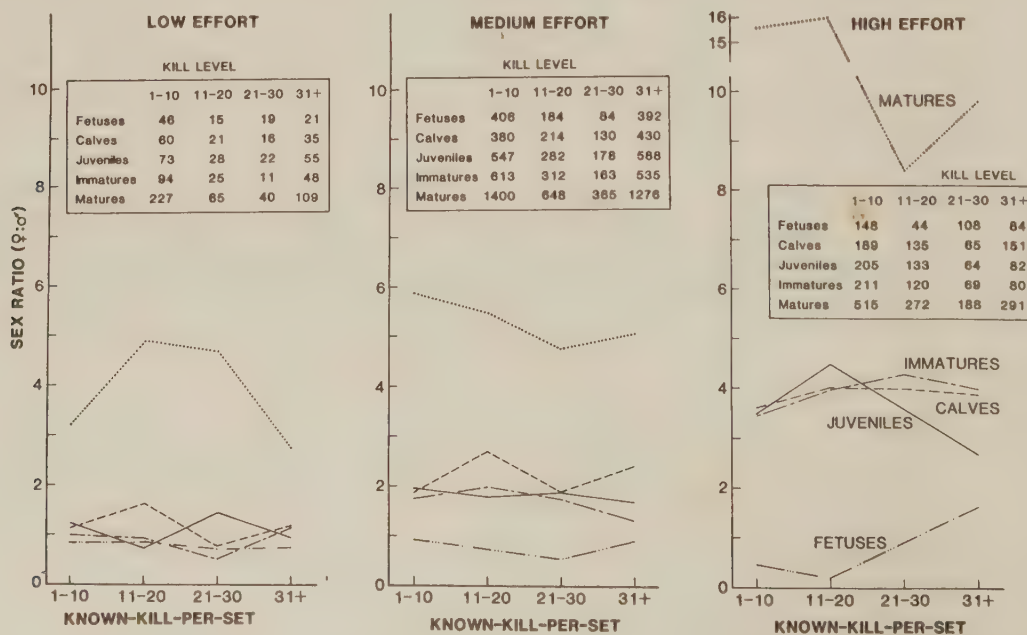
BIOLOGICAL SYSTEMS INVESTIGATIONS

Changes in Sex Ratio of Spotted Dolphins
Correlated with Changes in Fishing Effort

Fishery Biologists Aleta Hohn and Susan Chivers have examined the sex ratio (number of females per male) across different age and reproductive classes. The sample includes 1551 fetuses, 1826 calves (animals smaller than 130 cm or approximately 1 year of age and younger), 2257 juveniles (animals greater than or equal to 130 cm but less than or equal to 160 cm, the length at which differential growth of males and females begins), 2281 immatures (animals greater than 160 cm and not sexually mature), and 5396 adults (animals greater than 160 cm and sexually mature). All samples were collected by observers aboard tuna vessels. Hohn and Chivers found that changes in the sex ratio of spotted dolphins from the eastern tropical Pacific were significantly correlated with changes in fishing effort.

Hohn and Chivers tested the effect of fishing effort by examining differences in sex ratio between areas of high, medium, and low fishing effort. Because there is a known bias in the sex-ratio of animals from "small-kill" sets and the calving season is diffusely seasonal, they stratified by kill-per-set and season. They defined four levels of kill-per-set: 1-10, 11-20, 21-30, and greater than 30 animals, and four seasons: January-March, April-June, July-September, and October-December. Although season may have been a particularly important factor for fetal or calf sex ratios because of the breeding cycle, the pattern of sex ratios found within each area persisted, regardless of kill level or season. They did, however, find a bias in the representation of sexes in small kill sets, and therefore included kill level stratification in further analyses.

The results show significant differences in sex ratio for all age classes, except fetuses, at all three levels of effort (Figure 1). The sex ratio for fetuses in all three areas,



characterized by high, medium and low fishing effort, is slightly biased in favor of males, with approximately 0.8 females to each male. The sex ratio of calves becomes more highly skewed in favor of females as fishing pressure increases. In low-effort areas the sex ratio of calves is near parity, in medium-effort areas the ratio is 2 females to 1 male, and in high-effort areas the ratio is approximately 3.5-4.0 females to 1 male. The sex ratio of fetuses through gestation and that of calves through the first year of life in each area was examined and no significant changes have been found. That is, no progressive change in sex ratio occurred with age up to one year within a given effort area. Sex ratio of fetuses remains near parity throughout gestation and most likely becomes skewed shortly following birth.

As with calves, the ratio of females to males for juvenile, immature, and mature animals becomes highly skewed towards females with increased fishing effort. The effect is most pronounced in mature animals. There, the sex ratio is approximately 4:1 in low-effort areas, approximately 5:1 in the medium-effort areas, and exceeds 9:1 for large-kill sets (the least biased kill-per-set level) in high-effort areas.

Variability in sex ratios of mammals is common, and, in fact, many terrestrial mammals exhibit sex ratios which fluctuate with population density. Although it is not yet possible to equate fishing effort with density for these dolphin populations, examination of terrestrial mammal species may be instructive. In general, sex ratios at birth are slightly in favor of males and thus, males often predominate from conception through birth. This is what Hohn and Chivers observe in dolphins from all fishing-effort areas. However, male mortality rates exceed those of females throughout life, so the sex ratio of adults frequently favors females. Species exhibiting this pattern are fur seals, elephant seals, rats, humans, as well as a number of ungulate species.

Clearly, mammals are able to invest selectively in their offspring. Increased preweaning investment in males has been observed in both red deer and elephant seals as well as other species. The increased preweaning investment is manifested as heavier birth weights, faster growth rates, and later weaning dates and resulting in sexually dimorphic adults. This pattern is accentuated in strongly polygynous species. Mammalian species, such as wood rats, zebras, and feral horses, which show little sexual dimorphism nevertheless exhibit variable sex ratios, suggesting that selective investment in young has adaptive significance for all polygynous species. The ability to vary the sex ratio of offspring enables a female to respond to changing conditions in such a way as to maximize her reproductive success.

In addition to selective post-natal investment in female or male offspring, females of many species have been observed to produce males when they are in a "good condition" and females

when they are in "poor condition." Females in good condition will produce the healthiest young and a healthy male will produce the most number of grandchildren, thus maximizing her reproductive potential. Conversely, production of female offspring results in the highest returns when conditions are less than adequate to produce a top quality male. Synonymous with poor condition, the term stress in the literature has most often been used to refer to nutritional stress, although it may also be used to describe behavioral and physiological conditions. Whatever the descriptor, stress or poor condition, the result, in most animals, is a sex ratio in which there are more females than males. Among ungulate species, populations considered stressed are frequently those subjected to excessive mortality, predation and hunting, which may or may not be associated with nutritional stress. These populations exhibit a sex ratio favoring females at the time of birth.

The spotted dolphin population of the eastern tropical Pacific may be considered to be stressed. Although food may be plentiful because of reduced population levels, an element of stress must be induced by fishery activities. Sets on larger schools of dolphins are preferred by the tuna fishery because of the correspondingly larger number of tuna they are associated with. The larger schools are also likely to be breeding schools and to contain a higher proportion of mature females. Fishing operations which include an initial and often extensive chase prior to encirclement must be disruptive because the operations interrupt foraging and other normal activities. Additionally, in heavily fished areas, females are likely to have been set on repeatedly, thus increasing the level of stress. Those areas fished for the longest time and with the greatest regularity exhibit a sex ratio most highly skewed in favor of females.

Thus, if information supplied by studies of a variety of mammalian species is applicable, general condition of the population may be inferred from the examination of sex ratios. Further evaluation must consider other reproductive and growth rate parameters, including body condition, annual pregnancy rate, lactation period, calving interval, and age at sexual maturation. In concert with examination of many life history traits and results from a 5-year research vessel survey monitoring changes in population levels, the results presented here may be applicable to monitoring trends in the population. (A. Hohn, FTS 893-6202)

HONOLULU LABORATORY

Honolulu, Hawaii

INSULAR RESOURCES INVESTIGATION

Alfonsin Development Described

During a presentation at the recent meeting of the American Society of Ichthyologists and Herpetologists in June 1986 at Victoria, British Columbia, Bruce C. Mundy, Fishery Biologist, described the newly identified larvae of alfonsin, Beryx splendens, collected at the Hancock Seamounts, 200 nautical miles north of Midway Island. The alfonsin is the second most important species in the Emperor Seamounts fishery north of the Hawaiian Islands. Stocks of alfonsin declined after intensive fishing by Soviet and Japanese fleets. As a result, the seamounts within the Fishery Conservation Zone around the Hawaiian Islands have been closed to foreign fishing. The staff of the Honolulu Laboratory's Seamount Resources Study Program is monitoring the recovery of the stock during the closure, as well as gathering new information on the life histories of important species for use in managing the fishery. Until recently, almost nothing was known about the early life history of the alfonsin. This impeded the understanding of alfonsin recruitment to the seamounts.

Alfonsin larvae (Figure 1) are easily identified by their shape, pigment, head spines (at larger sizes), and by the early development of long pelvic and dorsal fin rays. Now that the larvae can be identified, preliminary studies of their distribution and biology are in progress. Larval alfonsin are

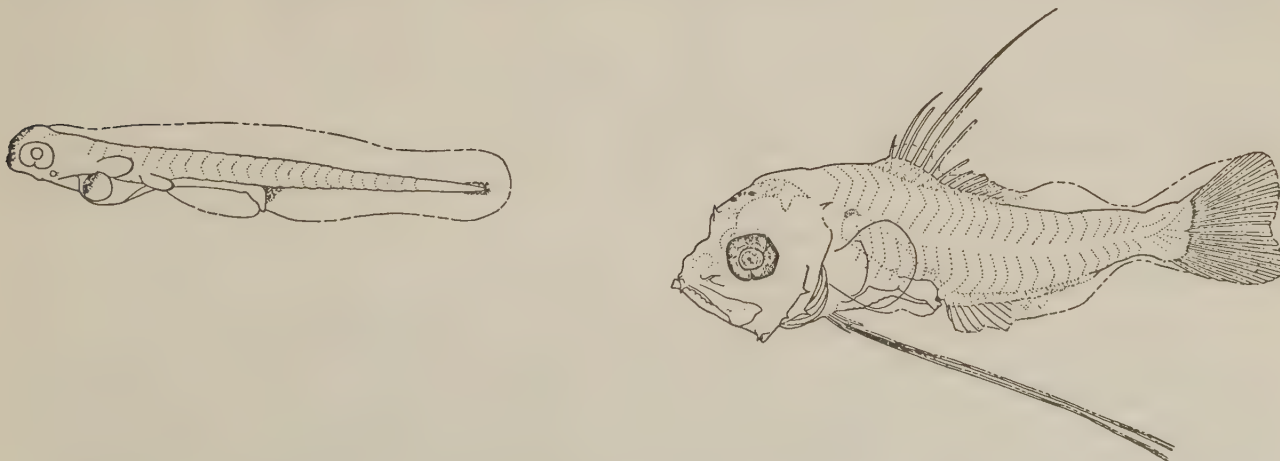


Figure 1. Larval alfonsin, Beryx splendens, collected at the Hancock Seamounts in July 1985: (left) 3.0 mm standard length; (right) 5.3 mm standard length.

present at the Hancock Seamounts during summer. They are found almost entirely in the upper 50 m, where they are susceptible to drift in surface currents. Indeed, the larvae were found to be much more abundant at a site 20 km away from the seamounts, where spawning adults do not occur, than directly above the seamounts. Identification of the larvae now makes it possible to study drift away from the region of spawning and the mechanism of recruitment to the seamounts. In addition, the identification allows specimens to be collected for use in age analysis to determine growth rates during larval life. (B. Mundy, (808) 943-1221).

Preliminary Estimate Made of Pearl Harbor Nehu Biomass

David A. Somerton, Fishery Biologist, has completed preliminary biomass estimates for the Pearl Harbor nehu, using the egg production method, for each week between May 1 and October 9, 1986. Over this time, the spawning stock averaged 1.55 t (SD = 0.88) and ranged between 0.58 and 3.91 t. The variance of each weekly biomass estimate is quite large due to the lack of a sufficient number of independent adult samples. In the next phase of the study, Somerton will examine variability between samples and between weeks in the reproductive parameters of nehu (proportion of adult females spawning, sex ratio, fecundity) to determine if and over what time scale averaging of parameter estimates can be used to reduce variance. So far it appears that the specific fecundity (eggs per gram body weight) increased steadily between May and October and that mean adult body weight decreased. Over this same period, the proportion of females spawning each night fluctuated in a pattern suggesting that periods of frequent spawning lasting several weeks alternate with periods of relatively infrequent spawning. The possible relationships between spawning frequency and food (copepod) abundance will be investigated soon. (D. Somerton (808) 943-1221)

FISHERY MANAGEMENT RESEARCH PROGRAM

Responsibility Formally Assumed for Lobster Fishery Statistics

Staff of the Fishery Management Research Program continue to work on the Northwestern Hawaiian Islands (NWHI) lobster fishery, which is being managed under a Fishery Management Plan (FMP) developed by the Western Pacific Regional Fishery Management Council (Council). On September 23, 1986, the Southwest Region delegated to the Honolulu Laboratory responsibility for collecting the catch and fishing effort logbooks and the trip sales reports that the vessel operators must submit under the FMP regulations. This action represents mostly an administrative

change in that, since the inception of the fishery, the Honolulu Laboratory has been collecting these data under an informal agreement with the Western Pacific Program Office of the Southwest Region. Ray F. Sumida, Fishery Biologist, with the assistance of Joan P. Thomason, Computer Programmer, is setting up a data report logger to ensure that proper records are maintained for the receipt of these records from the vessel operators. (R. Skillman (808) 943-1221)

Lobster Fishery Catch Statistics Summarized

Joan Thomason and Research Assistant Victor A. Honda completed editing lobster logbook data and produced computer summaries of catch and fishing effort through September. In September 1986, 5 vessels made 5 trips and fished 3 different areas; from January through September, 16 vessels had made 14 trips. The number of legal spiny lobster landed through September 1986 was 562,000, compared to 576,000 in 1985 (Figure 2). Cumulative catches of legal spiny lobster exceeded those in 1985 during the first five months of the year, but after May catches decreased. Likewise, the total catch of slipper lobster through September 1986 was nearly 958,000 compared to 883,000 last year (Figure 3). The cumulative catch of slipper lobster this year fell behind the cumulative catch in 1985 in only 1

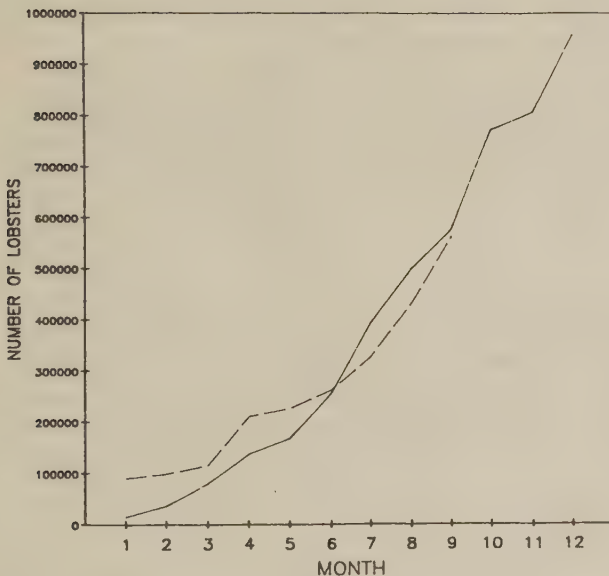


Figure 2. Cumulative catch of legal spiny lobster. Solid line is 1985 and broken line is 1986.

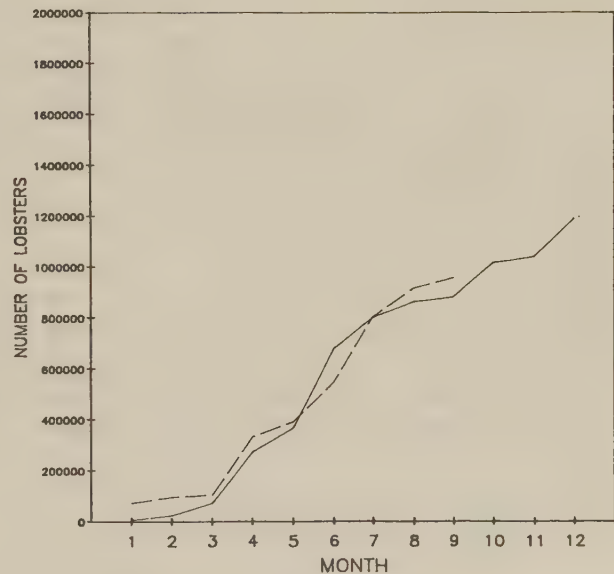


Figure 3. Cumulative catch of total slipper lobster. Solid line is 1985 and broken line is 1986.

month (June). The catch rate through September 1986 for legal spiny lobster was 0.60 per trap-night, which is less than the 1985 figure of 0.85. The 1986 catch rate for January, March and April exceeded the catch rate for those months in 1985, though not by much, and has been well behind the 1985 rate in all other months (Figure 4). For slipper lobster, the catch rate through September this year was 1.02, whereas it was 1.31 last year. The catch rate of slipper lobsters in 1986 exceeded that in 1985 in 4 months, but fell behind in three of the four peak summer months (Figure 5). In summary, the catch and catch rate of spiny lobster are down this year compared to last year, whereas for slipper lobster, the catch is up but the catch rate is down. (R. Skillman (808) 943-1221)

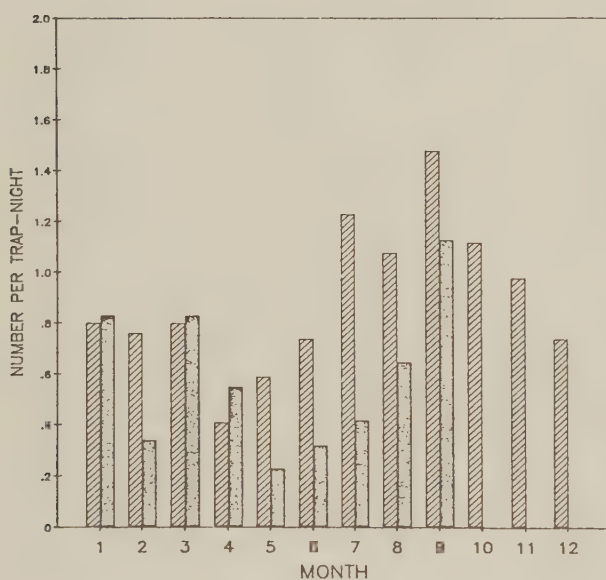


Figure 4. Monthly CPUE for legal spiny lobster. Striped bar is 1985 and stippled bar is 1986.

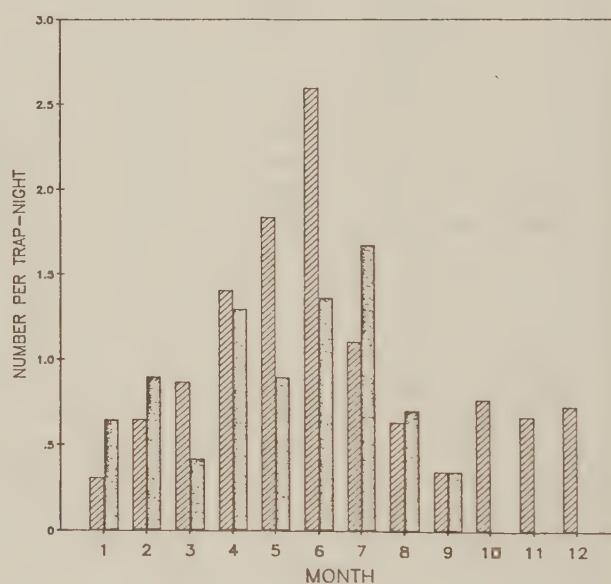


Figure 5. Monthly CPUE for total slipper lobster. Striped bar is 1985 and stippled bar is 1986.

Contract Report Completed

Paul D. Gates, cooperative researcher with the Western Pacific Regional Fishery Management Council and the University of Hawaii's College of Tropical Agriculture, completed a report entitled "Dynamics of fleet composition and vessel fishing patterns in the Northwestern Hawaiian Islands commercial lobster fishery: 1983-86" on a 5-month research project of the economics of the Hawaii lobster fishery. The report was coauthored by Dr. Karl C. Samples of the University of Hawaii. In the paper Gates and Samples analyze the entry and exit of vessels into the

lobster fleet from 1983 through mid-1986, discuss the increasing geographical dispersion of the fleet throughout the NWHI, and document the increasing intensity of fishing capacity (vessels carrying and fishing more traps). The data for the report were supplied by the Honolulu Laboratory and Western Pacific Program Office. The report is the first of several expected from the cooperative project which will also examine the market for lobster products and fleet economics. (S. Pooley (808) 943-1221)

Honolulu Laboratory Scientists Active on Fishery Monitoring Team

Robert Skillman, Leader of the Fishery Management Research Program, and Samuel Pooley, Industry Economist, as well as other SWFC staff, continue to serve on or work with the Council's Bottom Fish Plan Monitoring Team, specifically in developing modules for the annual report and developing a limited entry management scheme. Pooley has been developing the structure of the economics module for the first annual report. Phil Meyer, a Council contractor, presented his seventh draft of an access plan. The Monitoring Team found the basic tenets of the plan acceptable, but they noted a number of areas needing revision before a final document is presented to the Council. (R. Skillman (808) 943-1221)

Strategic Planning Meeting Held

A two-part strategic planning meeting for Hawaii's aku (skipjack tuna) fishery was completed in October at the Honolulu Laboratory. Samuel Pooley served as the facilitator, and the participants included representatives from the harvesting and marketing sectors of the industry and from non-NMFS agencies. Shortly before this meeting, Pooley, Skillman, and Fishery Biologists Jerry A. Wetherall, and Christopher H. Boggs put together a package of potential resource research projects that the SWFC might undertake, based on the list of needs that the participants of the first planning session produced (see Report of Activities, July-August 1986). Proposals for future initiatives in assisting the short-term and longer-term needs of the aku industry were made by the participants and will be presented to the industry as a whole. A brief report by Pooley and Boggs on the sessions is nearing completion. (S. Pooley (808) 943-1221)

New Volume of Western Pacific Fishery Statistics in Production

David C. Hamm, Computer Systems Analyst, reports that processing of data from Guam for the production of Volume II of the Fishery Statistics of the Western Pacific is under way. This series of reports was established last year by the Fisheries Data Coordinating Committee of the Western Pacific Fishery Information

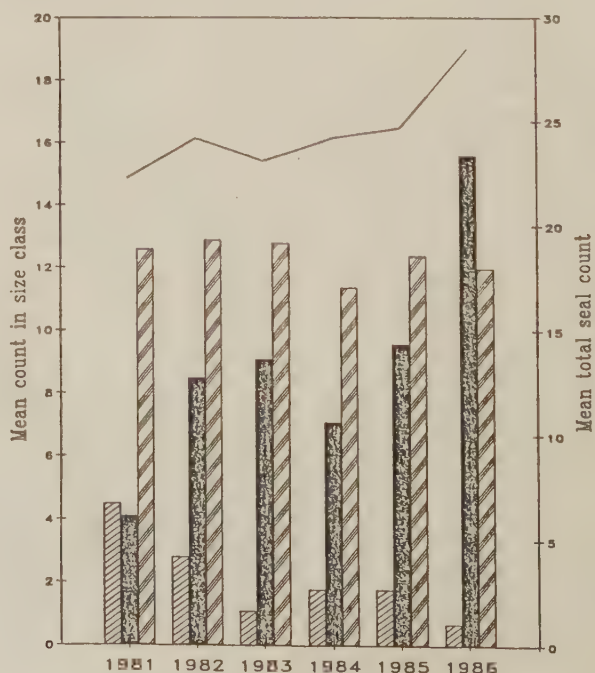
Network (WPACFIN) as the principal method of disseminating summary statistics on the fisheries of American Samoa, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Data are being summarized from three major data bases on Guam's fisheries, including commercial landings data from mid-1979 through 1984, offshore creel survey data for 1979 through 1984, and inshore creel survey data for 1983 and 1984. The report will include monthly and annual summary reports by species or species groups, as well as histograms and line charts of many of the most important statistics. The report will contain approximately 230 tables and 60 graphs. A laser printer was obtained to improve the quality of the report and increase the efficiency of its production. The final product is expected to be distributed by the end of November. (D. Hamm (808) 943-1221)

MARINE MAMMALS AND ENDANGERED SPECIES PROGRAM

Status and Recovery Potential of Kure Monk Seal Population Determined

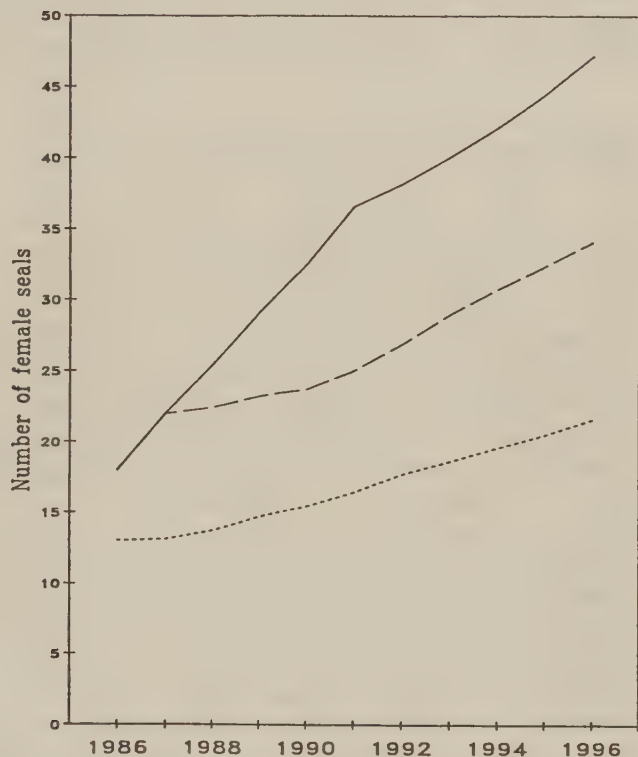
William G. Gilmartin, Leader, Marine Mammals and Endangered Species Program, and Tim Gerrodette, Fishery Biologist, have completed an assessment of the population status and recovery potential of the Hawaiian monk seal, Monachus schauinslandi, at Kure Atoll. The population at Kure, severely reduced from levels observed in the 1950s, has benefited from recent efforts to increase pup survival and introduce pups from other locations. The present ratio of immature to mature seals is high (Figure 6), a fact which bodes well for the future growth of the population, provided beach disturbance does not reduce survival of the immature females or cause them to leave Kure.

Figure 6. Mean counts of monk seals in three size-classes (bars) and mean total seal count (line) at Kure Atoll, 1981-86. Single-striped bar is pups; stippled bar is for juveniles and subadults; triple-striped bar is adults. Solid line is mean total seal counts.



Gilmartin and Gerrodette project population changes under different management options. Population growth is expected under all options (Figure 7). Nevertheless, the population growth rate will greatly increase if the Honolulu Laboratory continues its present efforts to augment the numbers of immature females by introducing pups and increasing pup survival. Moreover, further reductions in beach disturbance are necessary to optimize the recovery of the Kure Atoll seal population. (W. Gilmartin (808) 943-1221)

Figure 7. Ten-year population projections of the female monk seal population at Kure Atoll under three management options. Solid line is the population projection when three pups are added each year until 1991. The broken line projects no pups added after 1987. The dotted line is for no pups added.



Underdeveloped Monk Seal Pups Collected

John R. Henderson, Fishery Biologist, reports that four Hawaiian monk seal pups that were collected at French Frigate Shoals, Hawaii, this spring are currently being raised in Honolulu for release next year at Kure Atoll. The pups, all of which are female, were collected because they were underdeveloped when they were weaned from their mothers and were unlikely to survive their first year. Pup mortality is approximately 20% at French Frigate Shoals, higher than at other monk seal breeding islands. The higher mortality may partially result from premature weaning of pups at French Frigate Shoals. The causes of premature weanings are unclear, but they may be due to a relatively high density of females with pups in the preferred pupping areas, resulting in an exchange of pups by nursing females.

The four pups are being fattened on a diet of herring and smelt, supplemented with vitamins. They will also be carefully screened to detect any diseases which they might, if untreated, introduce to the Kure Atoll population. Contact with humans is minimized so that the seals will more easily learn to catch their own food.

Next spring the females will be moved to Kure Atoll and placed in a protective enclosure filled with reef fish. When the seals begin to catch fish for themselves, they will be released and allowed to join the five young female seals similarly rehabilitated over the past 2 years. The small resident population of seals at Kure now includes only two breeding females. (J. Henderson (808) 943-1221)

Hawaiian Monk Seal Production Up

Hawaiian monk seal pup production in the NWHI was up in 1986. At least 184 pups were born, an increase of approximately 20 pups over counts of the past 3 years. Known pup production in 1983, 1984, and 1985 was 163, 161, and 165 pups, respectively. Since 1983, personnel in the Honolulu Laboratory's Marine Mammals and Endangered Species Program have marked weaned pups at all breeding locations in the NWHI to monitor pup production and subsequent survival. In 1983, weaned pups were bleach marked at French Frigate Shoals (the major breeding area) and tagged at all other locations. Beginning in 1984, weaned pups have been tagged at all locations. Pups are tagged in each hind flipper with a plastic Temple Tag. Each tag bears an identifying number, is punched with a series of holes designating year, and also color coded by island. The final pup production count for a year includes all tagged pups and some pups that did not receive tags (pups that died and those still nursing at the end of the field season). Laboratory personnel tagged 171 of the 184 pups born in the NWHI in 1986. (T. Johanos (808) 943-1221)

DATA MANAGEMENT AND TECHNICAL SERVICES

Upgrading of Honolulu Laboratory Computer System Continues

David C. Hamm, Acting Chief, Data Management and Technical Services, reports that, as part of the upgrading of the Honolulu Laboratory's computer system, Supercalc 4 (a Lotus-like spreadsheet), Superproject (project management), and two statistical packages, Shazam (econometrics) and Systat (general statistical analysis) were purchased for the IBM PC-AT's. Also, a CP/M version of Turbo Pascal is now available on the Molecular. Surge protectors were installed for all of the Laboratory's IBM PC-AT's and for 20 of the most used Visual terminals, and

switches have been provided in some offices so that printers may be shared. Additional Bernoulli boxes were obtained for backing up the IBM PC-AT hard drives. (D. Hamm (808) 943-1221)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

Forecasting Ocean Climate of Water Masses Adjacent to and Downstream of Western Boundary Current (Subarctic) Confluence Zones

Variation in sea water temperature is one of the main factors affecting both marine life and global climatic variation. However, there are still many unknown mechanisms that control or disturb oceanic circulation and water mass distribution. Oceanographer Thang Pham has found evidence that cold water in the subarctic confluence zones influences the large-scale sea surface temperature distribution in the North Atlantic. By studying the sea surface temperature (SST) anomalies of three large areas which cover the Gulf Stream, the Labrador Current and the North Atlantic Current, his results show that there is strong negative correlation between the SST of the Labrador Current region and that of the Gulf Stream region, and positive correlation between the SST anomalies of the Labrador Current region and the North Atlantic Current region. In addition to that, the SST anomalies of the Labrador region lead the anomalies in the other regions by one month (Figure 1).

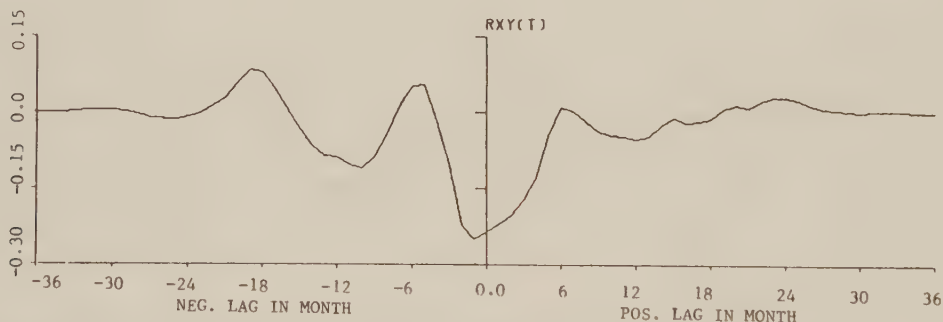


Figure 1. Cross-correlation function $R_{GN}(\tau)$ of the area-averaged SST anomaly of the Gulf Stream and that of the Newfoundland region. At its peak value of about -0.25°C^2 the Gulf Stream region lags one month behind the Newfoundland region.

The Labrador Current, mainly driven by wind, carries Arctic cold water southward. Its mass transport is much smaller than that of the Gulf Stream. However, its cold water which moves into a region of warm water of the Gulf Stream creates or enhances eddies and meanders in this region. The eddies or meanders disturb the circulation of the Gulf Stream, and consequently strongly affect the distribution of water masses in the adjacent and downstream regions.

Pham has recently found evidence of similar mechanisms in his preliminary study of the SST in the western boundary current confluence zones in the North Pacific (Figure 2). His results indicate that cold water carried southward by the Oyashio Current is contributing significantly to the variation of sea water temperature in the midlatitude North Pacific Ocean. A detailed study of wind stress and sea water temperature variation, on both vertical and horizontal scales in the North Pacific, is being carried out. In this study, Pham is looking at spatial and temporal relationships between variation of wind stress, sea water temperature of the Sea of Okhotsk and of the Oyashio Current region, and the variation of SST in the Kuroshio and in the Central North Pacific regions.

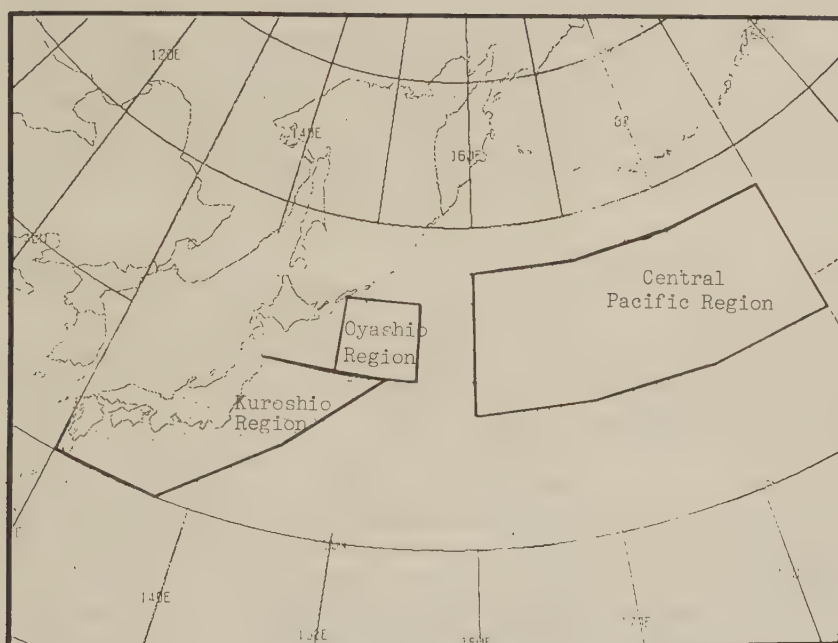


Figure 2. The Kuroshio, the Oyashio and the central North Pacific regions.

A wind index of the Oyashio - Sea of Okhotsk region will be developed and applied in efforts to forecast ocean climate variation which may be closely related to fisheries and global climate problems. (T. Pham (408) 646-3311)

PELAGIC FISHERY RESOURCES DIVISION

La Jolla, California

International Skipjack Year Program Volume Published

The Proceedings of the International Commission for the Conservation of Atlantic Tunas Conference on the International Skipjack Year Program was published on October 1, 1986. The conference was held in Santa Cruz, Tenerife, Spain, from June 21 through 29, 1983. This volume represents the completion of the Skipjack Year Program and the attendant research. The program was carried out by the International Commission for the Conservation of Atlantic Tunas. Dr. Gary Sakagawa served as the convener of the committee that organized and planned the research program, and as editor of the final 388-page volume. Southwest Fisheries Center scientists contributed six research papers to the volume. (G. Sakagawa, FTS 893-6333)

STOCK ASSESSMENT AND IMPACT ANALYSIS PROGRAM

Chapter on Seabird Relationships to Tropical Tuna and Dolphins Prepared

Fishery Biologist David Au and Biologist Robert Pitman submitted a chapter entitled, "Seabird relationships to tropical tuna and dolphins," to Joanna Burger of Rutgers University, Editor of a book to be called "Seabirds and Other Marine Vertebrates: Commensalism, Competition, and Predation." The book, which will be published by Columbia University Press, describes seabird interactions with fish and mammals (including fishermen) in various seas of the world and from an evolutionary perspective. Au and Pitman summarize their observations of the interactions between seabirds and yellowfin and skipjack tunas and with seventeen species or species groups of cetaceans in the eastern tropical Pacific. They describe two distinct faunal communities: in one community bird flocks co-occur with yellowfin tuna and dolphins, and in the other, flocks co-occur with skipjack or other small tuna, but not with dolphins. They describe the species makeup of the flocks with dolphins (about 75 percent were spotted and spinner) and they found that this seabird-dolphin association was linked through yellowfin tuna which feed with the birds. Au and Pitman present a hypothesis that explains the bird-tuna-dolphin association as an intersection of feeding tactics required to exploit certain configurations of prey. (D. Au, FTS 893-6339)

Billfish Tagging Increases During Past Three Years

During the past 3 years, tagging of striped marlin by recreational anglers has greatly increased. The reason for the increase has been the added support of the National Coalition for Marine Conservation for the NMFS tagging program, conducted by Fishery Biologist James Squire.

In 1985, 197 striped marlin were tagged and released, compared with 73 tagged in 1981 and 81 tagged in 1982. For the 1986 fishing season through November off southern California, a season of cool water temperatures, only 51 marlin have been tagged. The leading southern California billfish tagger is Don McPherson with four striped marlin; the leading captain is Doug Carson with four fish tagged and released. Both winners will receive awards sponsored by the National Coalition for Marine Conservation. Final results will be determined at the end of the season, which is usually mid-November; a list of participants will be published in the Southwest Fisheries Center 1987 Billfish Newsletter. (J. Squire, FTS 893-6376)

Changes in Longline Fishery Strategy Documented

Center scientists Gary Sakagawa, Atilio Coan and Norman Bartoo have completed a manuscript on "Patterns in longline fishery data and bigeye tuna catches," which details the historical shifts in fishing global strategy by the major longlining nations and examines the causal factors. Results indicate that in the Japanese longline fishery, fishing strategy changed from albacore to bigeye tuna as the target species in response to economic pressures. These pressures include increased operating cost, low albacore prices, and high prices for bigeye tuna for sashimi-grade fish. The results are supported by evidence that albacore catch rates have remained at high levels that were experienced by the Japanese fishery before the shift, and the shift occurred in the Pacific, Atlantic, and Indian Oceans approximately simultaneously. The manuscript will be presented to the International Commission for the Conservation of Atlantic Tunas annual meeting in Madrid and then published elsewhere. (G. Sakagawa, FTS 893-6333).

MULTI-SPECIES FISHERIES MONITORING AND DATA MANAGEMENT PROGRAM

Tuna/Dolphin Observer Data Maintained

Data pertaining to dolphins associated with the tuna purse seine fishery have been collected by observers for the past two decades. Staff of the Multi-Species Fisheries Monitoring and Data Management Program is responsible for the maintenance of

these databases. Recently, a thorough cross-referencing edit of the four major databases for 1978 through 1984 was completed by Biological Technician, Randy Rasmussen. Also completed was the standardized reformatting of all marine mammal effort and sightings databases (1971-1986). Another large task during the last few months has been the microfilming of the observers' original data collection forms. Rasmussen and Biological Technician Peter LaCivita have put on microfilm all forms (except life history) from 1971 to 1975 and from 1978 to 1984, inclusive. These data forms and the microfilm originals have been prepared for offsite storage; microfilm duplicates will be kept at the SWFC. A new microfilm reader and printer have been selected for purchase. (A. Coan, FTS 893-6377)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Nutritional Bioenergetics Studied in Yellowtail Rockfish

A major determinant of reproductive success (the number of viable, healthy larvae) in fishes is the provision of adequate nutrients to the eggs (and larvae in viviparous species). The proximal source of nutrients for reproductive development is the circulatory system of the female. Nutrients transported to the ovary originate from tissue storage depots, including liver, muscle, and adipose tissue. Oceanographer Bruce MacFarlane has begun a study to determine the qualitative and quantitative translocation of nutritional resources from maternal stores to the developing eggs and larvae of yellowtail rockfish (Sebastes flavidus). Since maternal nutrient storage and translocation are moderated by environmental factors, the goal of this research program is to establish a model to predict spawning success based on quantitative measures of biotic (intramaternal and extramaternal) and abiotic factors.

Mature female yellowtail rockfish have been collected monthly since April 1985 from the Cordell Bank, approximately 20 miles west of Point Reyes, from the chartered vessel Jaws and the NOAA Ship David Starr Jordan. The yellowtail rockfish population at Cordell Bank is considered to be a stable population subjected to relatively low fishing pressure. After the fish is captured by hook and line from depths of 50-150 m, blood is immediately withdrawn by cardiac puncture; the blood is stored on ice until it is returned to the laboratory where the serum is separated from blood cells. Fish specimens are stored on ice until dissection and tissue subsampling for nutrient measurements (usually the following day). Serum samples are analyzed for nutrients, inorganic ions, and compounds indicative of organ function; liver, muscle, and gonad tissues will be assessed for changes in lipid, protein, carbohydrate, water and ash content.

From a cursory inspection of data generated to date, concentrations of serum nutritional and structural compounds are elevated during the winter (November through February), which coincides with the period of rapid egg and larval development. Serum ion concentrations appear relatively stable throughout the year, as might be expected in a stenohaline environment. The greatest variations between monthly means were observed for potassium (approximately threefold) and phosphate (approximately twofold). Serum enzyme levels (e.g., LDH, alkaline phosphatase, transaminases) and other indicators of organ function (e.g., blood urea nitrogen, creatinine, bilirubin) have been recorded

for each specimen and will be used to determine pathological effects on reproductive functions and to correct serum nutrient data to assess normal, healthy profiles.

Data on serum nutrients, in conjunction with data on tissue lipids, carbohydrates, and proteins, morphometrics, fecundity, and ovarian histological data, will be analyzed in several ways to determine the nutritional energetics of yellowtail rockfish reproduction. They will be analyzed to chart temporal relationships between nutrient dynamics and ovarian development. Additionally, all data produced from measurements on individual fish will be analyzed to reveal relationships between variables of reproductive importance to define the range of nutrient-reproductive maturation profiles within the sample population. Variations in reproductive stage and age have been observed within monthly samples; therefore, all data will be grouped and assessed by age and ovarian maturation stage to characterize the age-specific nutritional sequence of egg-to-embryo-to-larval development. After this project, the effects of changes in environmental variables, such as temperature and food availability, on reproductive success will be determined with field measurements and controlled laboratory studies. (B. MacFarlane, FTS 556-0569)

Histological Studies of the Ovary of Yellowtail Rockfish Completed

To increase what is known about the reproductive biology of the yellowtail rockfish, Sebastes flavidus, Fishery Biologist Michael Bowers of the Tiburon Laboratory has completed histological preparations and will begin descriptive analyses of egg and embryonic development in this species. A complete seasonal reproductive cycle has been sampled by collecting 10 ovaries per month since May 1985 from the Cordell Bank area. Sampling will continue for the following reproductive season.

Oocyte stages will be based on cell diameters and nuclear and cytoplasmic changes. Cell diameters for monthly samples will be measured with a video coordinate digitizer. Embryogenic stage (fertilization to hatched larvae) determinations will be categorized by their histological, morphological, and cytological changes.

Another aspect being measured is the number (percentage) of atretic oocytes. Preliminary observations indicate oocyte atresia occurs mostly in yolked oocytes (early to late vitellogenesis). This information will be used to estimate fecundity more accurately.

Because of the rapid rate of embryonic development from fertilization to hatched larvae (30-40 days), intensive sampling is planned to begin in December. This sampling schedule will fill in the histological stages missed during the first year's collections.

The 1985-1986 spawning season should provide a good database with which to compare the succeeding seasons. Environmental, nutritive, and age-related influences on the reproductive efficiency of this species can be gathered by these comparisons. This information is useful and necessary in order to predict accurately the number of viable offspring. (M. Bowers, FTS 556-0565)

GROUNDFISH ANALYSIS INVESTIGATION

Widow Rockfish Assessed

Joseph Hightower and William Lenarz, Fishery Biologists, have completed a report on the "Status of the widow rockfish fishery" for the Pacific Fisheries Management Council. The report contains results of an analysis of data collected from the fishery between 1980 and 1985.

Hightower and Lenarz used both deterministic and stochastic cohort analysis techniques to estimate population size and rates of fishing mortality. The two approaches were used to examine assumptions made in a previous analysis to link year classes. Estimates from the cohort analysis were used in an age-structured simulation model to explore the effects of various harvest strategies.

Outcomes of the deterministic and stochastic cohort analyses were very similar. Thus the linkage suppositions appear valid. Results of the simulation indicate that the 1987 harvest should be 12,400 MT, higher than the advice for 1986 based on analysis by Hightower and Lenarz in 1985. The higher estimates are caused by increases in assessments of strength of recent year classes entering the fishery. In particular, the 1985 analysis indicated a weak 1980 year class, and the 1986 study indicates that the 1980 year class is about average. Increases also occurred in estimates of the strength of the 1978 and 1979 year classes.

Although estimates from cohort analysis of the strength of year classes that have been in the fishery for a number of years are fairly accurate, estimates for recently recruited year classes are not. Other sources of information on year-class strength are needed to reduce the uncertainty in management recommendations. Staff of the Tiburon Laboratory is conducting research aimed at developing indices of year-class strength for rockfish before recruitment to the fishery.

Members of the Groundfish Management Team accepted the assessment report by Hightower and Lenarz at its September meeting. The report will be part of the Council's annual collection of stock assessment documents. (W. Lenarz, FTS 556-0565)

GROUNDFISH COMMUNITIES INVESTIGATION

Whales, Fishes, and Seabirds Attracted to Late-Season Krill Swarms off Central California

Many marine predators have been attracted to extensive swarms of the euphausiid Thysanoessa spinifera off central California this fall. Along with the unusually large numbers of baleen whales observed at the swarm sites, there have also been over 84 humpbacks and 40 blues--more blue whales than recorded at any other time during the 16 years of whale counts in this area. Blue sharks and molas have also been unusually abundant, and over a dozen species of seabirds have been noted.

Not only has the activity been unusually intense this year, but it also has occurred unusually late in the season. According to Fishery Biologist Susan Smith, who has been studying the swarming behavior of this euphausiid in relation to the behavior of predatory fishes, the swarms generally occur (in central California) from April to July or August. This year, however, the euphausiid has been as abundant in September and October as it was in April. Obtaining samples from the swarm areas, Smith found that the feces of blue whales, as well the gut contents of yellowtail rockfish and Cassin's auklets, consist almost entirely of the euphausiid T. spinifera. Because the euphausiid swarms consist largely of individuals in spawning condition, the intensive predation they have suffered may have considerably affected the breeding population. (S. Smith, FTS 556-0565)

FISHERIES INFORMATION SYSTEMS & ADP

National Data Management Committee Meeting Held

The National Data Management Committee (NDMC) is made up of the data base administrators at each of the Centers and Regions. Dorothy Roll, Chief, ADP Operations, is the representative for the SWFC. The functions of the NDMC are to develop and recommend the policy and procedures for NMFS data processing, to coordinate and integrate NMFS Data and Information Management Systems, to review regional system implementation to ensure conformity with NMFS plans, and to recommend and monitor projects to improve ADP capabilities in support of NMFS mission.

The Committee met at the Northeast Fisheries Center in Woodshole, Massachusetts, on October 15 and 16. It was chaired by Hoyt Wheeland from the NMFS Office of Data Management and Information Systems (DMIS), Washington, D.C. Attending the meeting were Gene Heyerdahl and Jim Sergeant (NEFC), Mary Anne Treadway (SEFC), Darrell Tidwell (NWAFC), Dorothy Roll (SWFC), and Ray Tillery (DMIS). Jerry Hornof (SWFC/SWR) attended the first day's session. Annie O'Donoghue from NOAA attended the first morning's session to discuss the status of the A-76 review. Based on her review of the SWFC's "Management Review of ADP in the Southwestern U.S.," she recommended that the consolidated national report include work load data and a comprehensive statement of NMFS mission.

Wheeland reported on the progress of the Information Technology in the 1990's Plan (IT-95). The proposed plan, which has been approved by NOAA and the Department of Commerce for a cost of 3 million dollars per year for the next 4 years, is in the Office of Management and Budget office for final approval. When approved, the money will be spent on the procurement of the preferred hardware configuration: a minicomputer in each region linked to a central mainframe with access to a supercomputer. A minicomputer in the SWFC and (possibly) the NWAFC may not satisfy the needs of the Honolulu and Alaska laboratories. Because of Honolulu's geographic location, their needs must be considered as a special case in the proposed configuration.

An action item of national interest was the committee's review of Heyerdahl's survey on micro-based word processing systems. Based on that survey, the NDMC recommended that WordPerfect be adopted as the NMFS standard word processor for the exchange of documents between the Fisheries Centers and Regions. Wheeland stated that the transition from the existing word processing systems to WordPerfect would be an evolutionary process and that his office would investigate the possibility of site licenses for WordPerfect.

Before the meeting adjourned, Wheeland announced that Ray Tillery, as the newly named supervisor of the Data Management and Information Systems Office, is the new chairperson of the NDMC committee. Tillery assumed the chair by setting the locations and dates for the next three meetings: La Jolla, California, in February 1987, Seattle, Washington, in June 1987, and Washington, D.C., in October 1987. (D. Roll, FTS 893-6250)

Micro Users Group Formed for Sharing Information

Frank Ralston, Computer Systems Analyst, organized a meeting of microcomputer users at the La Jolla Laboratory on October 1, 1986. The meeting was open to all users of microcomputers at the La Jolla Laboratory--biologists, computer programmers, and secretaries. The participants decided to hold monthly meetings aimed at sharing ideas and information, as well as promoting more effective microcomputing within the Center. Meetings will be held on the first Wednesday of each month and will feature a demonstration or short seminar. A demonstration of the word processor WordPerfect (version 4.1) was scheduled for the November 5 meeting. An account of each meeting will appear in the ADP newsletter FISH n' CHIPS. (F. Ralston, FTS 893-6293)

STATUS OF PUBLICATIONS

PUBLISHED

Ankenbrandt, Lisa. 1986. The occurrence of young skipjack tuna (*Katsuwonus pelamis*) in the diet of adult skipjack from the southwestern Atlantic Ocean, pp. 299-300. In: P. E. K. Symons, P. M. Miyake and G. T. Sakagawa (eds.), Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

Stomach contents of skipjack tuna captured in 1981-1982 by pole-and-line gear off the southern coast of Brazil were analyzed for the presence of larval and juvenile skipjack. The percent frequency of occurrence, percent number and percent volume were evaluated. Of the 1,041 stomachs that were examined for food, 436 were empty. The mean volume of food in all stomachs analyzed was 36.9 ml, of which 18.9 ml was bait and 18.0 ml was prey. Larval and juvenile skipjack were not present in the diet of adults from this study.

Argue, A. W., P. Kleiber, R. E. Kearney and J. R. Sibert. 1986. Evaluation of methods used by the South Pacific Commission for identification of skipjack population structure, pp. 242-251. In: P. E. K. Symons, P. M. Miyake and G. T. Sakagawa (eds.), Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

The use of data from blood genetics, tagging, growth, maturity, juvenile occurrence, and parasite studies for examining skipjack population structure is discussed in light of experience by the Skipjack Survey and Assessment Programme of the South Pacific Commission. Results from analyses of these data support several different hypotheses of skipjack population structure in the Pacific Ocean. This confusion reflects, in part, the limited information content of these data for inferring population structure. Therefore unconditional support for any one hypothesis is misleading, particularly as the potential for fishery interactions differs markedly amongst the hypotheses.

Before choosing a most likely hypothesis of skipjack population structure, gaps in the basic biological data, specifically geographical distribution of spawning and movement of pre-recruits, should be filled. Obtaining comprehensive new data will be costly and time-consuming and will not overcome inherent weaknesses of the traditional methods. There is a need to weigh the benefits to be gained from improved knowledge of population structure against the benefits to be gained from a better understanding of interaction amongst components of the rapidly expanding fishery for skipjack.

- Au, David W. K. 1986. Skipjack population dynamics: Is it qualitatively different from that of other tropical tunas? pp. 189-197. In: P. E. K. Symons, P. M. Miyake and G. T. Sakagawa (eds.), Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

Some aspects of the population dynamics of skipjack, yellowfin, and bigeye tuna are compared, and an explanation is sought for the large variations in catches of skipjack and the lack of evidence for decline in its populations following fishing. Compared with yellowfin and bigeye, skipjack is an earlier maturing species with higher natural mortality and more variable populations. It follows that its populations have fewer age classes, are more variable from changes in year class strength and availability, and have higher production/biomass ratios. Skipjack may be considered more 'r-selected' than the other tunas, i.e. the species has probably evolved for greater success in the more variable habitats of the tropical ocean through increased potential for population growth. Skipjack therefore should also be expected to be more opportunistic and migratory in comparison to the other tunas. The tropical tunas, but especially skipjack, appear to have specialized in the energy-expensive foraging strategy of sustained, fast-swimming search over large areas, and this is the likely link between their high metabolic and natural mortality rates. It is further suggested that the higher natural mortality of skipjack is more density dependent than in the other tunas, and that this reduces the effects of fishing.

- Au, David W. K. and Robert L. Pitman. 1986. Seabird interactions with dolphins and tuna in the eastern tropical Pacific. The Condor 88:304-317.

Bird flocks associated with dolphins in the eastern tropical Pacific are described from observations obtained during eight cruises that took place from January to March of 1976, 1977, 1979, and 1980. In the northern tropical waters between latitudes 5°N and 30°N, 43% to 53% of bird flocks co-occurred with dolphins. In equatorial and southern subtropical waters between latitudes 5°N to 12°S and in the central Pacific less than 8% of the flocks were associated with dolphins. In northern tropical waters about 70% of dolphin schools associated with flocks were composed of spotted or spotted plus spinner dolphins; conversely, 59% of spotted dolphin and 96% of spotted plus spinner dolphin schools co-occurred with bird flocks. Most large schools of these dolphins were associated with birds, and the number and diversity of bird species increased with dolphin school size. The average species composition of birds in dolphin-associated flocks of northern tropical waters was: boobies 41.7%, Wedge-tailed Shearwaters (Puffinus pacificus) 31.4%,

jaegers 12.8%, Sooty Terns (Sterna fuscata) 6%, frigatebirds 3.6%, and others 4.5%. Positive statistical associations were found among these bird species, which are explained by common attraction to food made available by feeding yellowfin tuna. In the southern latitudes and in the central Pacific, flocks were dominated by Sooty Terns, and few flocks were associated with dolphins. These flocks appeared to be associated with skipjack rather than yellowfin tuna.

Balazs, G. H., and S. Hau. 1986. Lepidochelys olivacea (Pacific ridley). Herpetol. Rev. 17(2):51. [Note]

Bindman, Andrew G. 1986. The 1985 spawning biomass of the northern anchovy. Calif. Coop. Oceanic Fish. Invest. Rep. 27:16-24.

The 1985 spawning biomass of the central subpopulation of the northern anchovy (Engraulis mordax) is 522,000 metric tons (MT). This estimate was made using the egg production method, which computes the spawning biomass as the ratio of the daily egg production rate (eggs per day for the entire population) and the daily specific fecundity (egg per day per metric ton). For the entire population, the egg production rate was 16.95×10^{12} eggs/day/MT. In 1985 anchovy eggs were found farther offshore than in any survey since the egg production method was first employed in 1980. A significant number of eggs spawned far offshore may have been missed by the survey, thus biasing the estimate downward.

Fiedler, Paul C. 1986. Offshore entrainment of anchovy spawning habitat, eggs, and larvae by a displaced eddy in 1985. Calif. Coop. Oceanic Fish. Invest. Rep. 27:144-152.

In early 1985, a recurrent anticyclonic eddy, normally located about 400 km southwest of Point Conception, was displaced toward the offshore limit of the northern anchovy spawning range in the Southern California Bight. The anomalous location of the eddy, and surface flow patterns associated with it were determined from hydrographic data and satellite imagery. Productive surface waters of 14°-15°C, characteristic of the preferred spawning habitat of northern anchovy, were entrained from within the Southern California Bight by the eddy. Eggs were found 150 km farther offshore than in 1980-84, because of a combination of spawning habitat extension and advection. The eggs and subsequent larvae were removed from the usual larval feeding grounds within the bight. This extraordinary displacement apparently had little or no effect on recruitment in fall 1985.

Goldberg, Stephen R. and David W. K. Au. 1986. The spawning of skipjack tuna from southeastern Brazil as determined from histological examination of ovaries, pp. 277-284. In: P. E. K. Symons, P. M. Miyake and G. T. Sakagawa (eds.), Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

A total of 961 skipjack tuna ovaries from southeastern Brazil was examined to determine their reproductive condition. The Brazilian fish were sampled from November 1981 to July 1982 from the coastal area south of Cabo Frio between 22°S and 28°S latitude. A portion of the population was in near spawning condition in November and this condition continued through March. Ovaries obtained during May-June were mainly regressed. The smallest sexually mature female in our sample was 510 mm. The minimum gonad index of mature fish was 30. Histologically mature ovaries represent a wide range of gonad indexes, including ripening and recently spawned conditions.

Graves, John E. and Andrew E. Dizon. 1986. Mitochondrial DNA genetic similarity of Atlantic and Pacific skipjack tuna and its management implications, pp. 237-241. In: P. E. K. Symons, P. M. Miyake and G. T. Sakagawa (eds.), Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

Restriction enzyme analysis of mitochondrial DNA (mtDNA) provides the most powerful, practical tool currently available for determining the genetic basis of population structure. This technique applied to skipjack tuna from the Atlantic and Pacific Oceans demonstrated no significant genetic differentiation between fish from different ocean basins although within-sample variation was detected. These results are consistent with the lack of morphological and electrophoretic differentiation of Atlantic and Pacific skipjack tuna found in previous studies and strongly suggest sufficient gene flow between ocean basins to prevent genetic differentiation. As no significant genetic differentiation was exhibited between Atlantic and Pacific skipjack tuna it is unlikely that genetically distinct stocks exist within the Atlantic Ocean. Consequently, any subdivisions of Atlantic skipjack into management units will have to be based upon non-genetic criteria.

Holland, K., R. Brill, S. Ferguson, R. Chang, and R. Yost. 1985. A small vessel technique for tracking pelagic fish. Mar. Fish. Rev. 47(4):26-32.

Tracking of pelagic fish has previously been conducted from large research or fishing vessels, both of which are expensive to operate. We have adapted advances in ultrasonic tracking technology to permit tracking of pelagic

fish from a small (33-foot) vessel. Sportfishing techniques have been successfully employed to capture fish for tracking.

The use of a small vessel has many advantages including maneuverability in congested areas, the ability to work both offshore and close to shore, high responsiveness to changes in fish behavior, and low operating costs. Low operating costs allow the vessel to be utilized over extended periods, thereby permitting replication of experiments. High quality data on the vertical and horizontal movements of pelagic fish have been acquired for periods of up to 6 days. These techniques could be utilized to track fish inexpensively in a wide range of locations.

Hunter, John R., A. W. Argue, William H. Bayliff, Andrew E. Dizon, Alain Fonteneau, Daniel Goodman, and Gunter R. Seckel. 1986. The dynamics of tuna movements: an evaluation of past and future research. FAO Fish. Tech. Pap. 277, 78 p.

Weaknesses in understanding of tuna distributions and movements have constrained the development of rational management policies. Uncertainties exist in: the selection of management plans and catch and effort data that are representative of a stock; quantification of exchange of adults among management jurisdictions and fishing gears; and identification of the relationships between the environment and tuna movements. This report summarizes a series of discussions between a panel and groups of experts on how to increase understanding of these and other tuna management problems. We discuss the uncertainties in current management policy caused by lack of understanding of tuna movement dynamics. We describe and evaluate the research approaches presently used to describe the movements of tunas--mark and recapture and acoustic tracking--and those which might be used or are just being applied, including new tagging systems, measurement of physiological state and microconstituents of mineralized tissue. Actions needed to improve the knowledge of tuna movements are: 1) establish international arrangements to share tuna movement data, to analyse movements on an oceanwide and worldwide basis and to link international oceanographic programs; 2) increase number and kinds of observations of movements of tuna in the vertical plane; 3) develop and use technology for tracing the actual paths followed by tunas over extended periods and for measuring movements independent of the fishery; and 4) conduct intensive studies on tuna movement dynamics which combine old with the new technologies discussed in the report.

Lenarz, William H. and Tina Wyllie Echeverria. 1986. Comparison of visceral fat and gonadal fat volumes of yellowtail rockfish, Sebastes flavidus, during a normal year

and a year of El Niño conditions. Fish. Bull., U.S. 84:743-745.

MacGregor, John S. 1986. Relative abundance of four species of Sebastes off California and Baja California. Calif. Coop. Oceanic Fish. Invest. Rep. 27:121-135.

Estimates of relative abundance of rockfish larvae were made for the area from San Francisco to southern Baja California. Over the 14 years studied, 30% of spawning occurred in February, 18% in January, 17% in March, and 12% in April. For the four identified species of rockfish larvae, peak spawning occurred in February (65%) for S. jordani; in January (45% and 40%, respectively) for S. levis and S. paucispinis; and in April (32%) for S. macdonaldi.

Half of the S. jordani larvae were taken within 10 nautical miles of land. About half of the other three species were taken within 20 nautical miles of land. Sebastes larvae were most abundant off San Francisco and Monterey and in the area of the Channel Islands off southern California, with the former area accounting for 53% of all larvae and the latter for 35%.

Mendelssohn, R. and Cl. Roy. 1986. Environmental influences on the French, Ivory Coast, Senegalese and Moroccan tuna catches in the Gulf of Guinea, pp. 170-188. In: P. E. K. Symons, P. M. Miyake and G. T. Sakagawa (eds.), Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

Both local and broadscale dynamic relationships were studied between catch per unit of effort (CPUE) for yellowfin and skipjack tunas in the Gulf of Guinea, and sea-surface temperatures (SST), and wind speed. The results suggested by a particular temperature during one time period will lead to high CPUE, while at another it will lead to low CPUE. Our analysis was not restricted to where fishing actually occurred.

We used a recently developed algorithm to complete missing CPUE and environmental data. Models were developed for eleven separate sub-areas of the Gulf of Guinea. Details of the method are provided in an appendix. Results from these models suggested that the environmental variables under study reflected an oceanographic process involving upwelling and concentration of nutrients a month prior to good fishing, followed by arrival of relatively warmer waters two weeks prior to good fishing.

We calculated dominant modes of variability for each parameter in time and space by six week and one year periods. The dominant mode for SST showed a space-time movement that was consistent with a recently developed theory of remote forcing in the equatorial Atlantic.

The dominant modes for CPUE for both yellowfin and skipjack showed relatively little discernible pattern. However, when dominant modes were calculated between SST and CPUE for the same periods and species of fish, the CPUE exhibited the same movement in space and time as SST, at about the same speed. This suggested the predictability of CPUE was largely due to a broadscale oceanographic process, which may have been associated with remote forcing in that region.

Methot, Richard D. 1986. Frame trawl for sampling pelagic juvenile fish. Calif. Coop. Oceanic Fish. Invest. Rep. 27:267-278.

The frame trawl is a micronekton net designed to sample pelagic larval and juvenile fish that avoid plankton nets and pass through the mesh of large midwater trawls. The mouth of the frame trawl is a rigid, square frame with an area of 5 m². The bridle attaches at two points and leaves the mouth relatively unobstructed and vertical at all tow speeds. A modified Isaacs-Kidd depressor can be attached behind the frame for midwater sampling, or floats can be attached for surface sampling. The frame trawl compares favorably with other similar-size samplers. In sea trials, juvenile anchovy and other species up to 200-mm anchovy larvae have been collected.

Methot, R.D., Jr. 1986. Management of Dungeness crab fisheries, pp. 326-334. In: G.S. Jamieson and N. Bourne (eds.), North Pacific Workshop on Stock Assessment and Management of Invertebrates. Can. Spec. Publ. Fish. Aquat. Sci. 92.

Management of Dungeness crab fisheries in the states of California, Oregon, and Washington was reviewed by the Pacific Fishery Management Council in 1979 and may be considered in three categories: conservation of the resource, maintenance of product quality, and reduction of conflicts. Size limits and prohibition of landing female crabs are the primary conservation measures. Additionally, escape ports in the crab traps reduce wastage. Season closures maintain product quality by reducing the harvest of recently molted crabs. Area closures reduce conflict between commercial and recreational fishermen.

Current management measures seem sufficient to prevent biological overexploitation but may not be optimal. Size limits reduce the necessity for a prohibition on harvest of females. Size limit levels may be too large when enforcement, optimum yield and genetic selection issues are considered. Consideration of the optimal level of effort in the crab fishery is complicated by the multispecies nature of the west coast's fishing fleet. High crab abundance during the late 1970s resulted in an increase in the size of the crab fleet and a large fraction of legal-sized male

crabs are now harvested in the first few weeks of the season. Efforts to deal with this apparent overcapacity must consider the great mobility of vessels between the crab, salmon, albacore, shrimp, and groundfish fisheries.

Moser, H. Geoffrey, Barbara Y. Sumida, David A. Ambrose, Elaine M. Sandknop, and Elizabeth G. Stevens. 1986. Development and distribution of larvae and pelagic juveniles of ocean whitefish, Caulolatilus princeps, in the CalCOFI survey region. Calif. Coop. Oceanic Fish. Invest. Rep. 27:162-169.

Ocean whitefish larvae occurred in 88 tows taken on CalCOFI plankton surveys from 1954 to 1981. The robust larvae develop a distinctive array of spines and spiny ridges in the head region. The body becomes covered with minute spines, which develop on each scale. Larvae also have a characteristic pattern of melanistic pigmentation, which makes it possible to identify early stages that have not yet developed head spines.

Larvae occurred from Ensenada (CalCOFI line 100) to Magdalena Bay (line 140) and seaward to Guadalupe island. Occurrences were concentrated off central Baja California; only 20% of the positive tows were north of Sebastian Viscaino Bay. It is apparent from the distribution of larvae that ocean whitefish populations off southern California are recruited from Baja California.

Parrish, Richard H., Donna L. Mallicoate, and Richard A. Klingbeil. 1986. Age dependent fecundity, number of spawnings per year, sex ratio, and maturation stages in northern anchovy, Engraulis mordax. Fish. Bull., U.S. 84(3):503-517.

Maturity stage data from fishery sampling programs and ovarian histological data from research cruises were used to develop a method for determining the age-specific number of spawnings per year and annual fecundity of the central stock of northern anchovy, Engraulis mordax.

The sex ratio was found to be size and age dependent in both the fishery and trawl surveys with females increasingly dominant in the larger and older size and age classes. The overall sex ratio in trawl surveys was nearly 1:1; the fishery data favored females 1.48:1. The magnitude and duration of maturity stages were size and age dependent with peak spawning occurring earlier in the season in younger fish. Maturity stages and histological classes with hydrated eggs showed essentially the same diurnal pattern for nightly spawning activity indicating that the presence of hydrated eggs could be used as an index of daily spawning. The daily spawning incidence and total annual fecundity were found to be heavily age dependent. Females in their first spawning season had an average of 5.3 spawnings, while those in their fourth had an average of 23.5 spawnings. When combined with

the higher batch fecundity of larger fish this results in 4+ year-old females producing nearly 5 times as many eggs per unit of weight as 1-year-olds. When the age-specific fecundity and sex ratio in the fishery are combined it is apparent that the catch of a ton of 4+ year-old northern anchovy reduces the reproductive potential of the stock 7.3 times as much as the catch of a ton of 1-year olds.

It was concluded that age-specific fecundity in multiple spawning fishes is of greater significance for management than previously thought. It is also significant that much of the observed variance in stock-recruitment relationships for multiple-spawning fishes may be due to the fact that spawning biomass is a poor index of the egg production and reproductive potential of the stock.

Polovina, J. 1986. Fortunes to be made on the deep slopes. *Pacific Islands Monthly* 57(10):32-33.

Reilly, Stephen B. and Jay Barlow. 1986. Rates of increase in dolphin population size. *Fish. Bull., U.S.* 84(3):527-533.

Annual finite rates of increase in dolphin population size were estimated to vary up to a maximum of 1.09, using simulation, based on ranges in vital rates. Vital rate ranges were defined from values reported in the literature where possible, otherwise by making assumptions about biological or logical limits. Given information on current values, or limits, of one or more vital rate, one can use the figures presented to determine ranges of possible rates of increase in population size. The highest rates estimated here (up to 1.09) are probably unrealistic, because of the unlikely combinations of high fecundity and low mortality needed to achieve them.

Sakagawa, Gary T. 1986. Skipjack fisheries in the western Atlantic, pp. 99-103. In: P. E. K. Symons, P. M. Miyake and G. T. Sakagawa (eds.), *Proceedings of the ICCAT Conference on the International Skipjack Year Program*, Madrid, 1986.

Available information on skipjack tuna in the western Atlantic Ocean is reviewed to identify areas where skipjack fisheries might be developed. Areas in the Gulf of Mexico, Caribbean Sea and off southeastern Brazil appear promising areas for development. Utilization of fish aggregating devices and new purse seining techniques are suggested as possible methods for concentrating schools and for catching them more efficiently.

Sakagawa, G. and A. Coan. 1986. Some recent changes in the Atlantic skipjack tuna fishery, 104 p. (Abstract) In: P.E.K. Symons, P.M. Miyake, and G.T. Sakagawa (eds.), *Proceedings of the ICCAT Conference on the International Skipjack Year Program*, Madrid, 1986.

ICCAT's International Skipjack Year Program was instrumental in drawing attention to the presence of the underutilized resource of skipjack tuna (Katsuwonus pelamis) in the Atlantic Ocean and in encouraging increased exploration and exploitation of the resource. Comparison of fisheries statistics for the period before 1979 and from 1979 and afterwards, when the four-year program was in effect, demonstrates that the fisheries for skipjack tuna have undergone expansion and changes. The Atlantic catch of skipjack tuna, for example, increased from an average of 91,300 MT in 1975-78 to an average of 118,300 MT in 1979-82.

Schmitt, Patricia D. 1986. Prey size selectivity and feeding rate of larvae of the northern anchovy, Engraulis mordax Girard. Calif. Coop. Oceanic Fish. Invest. Rep. 27:153-161.

A series of laboratory feeding experiments was conducted with larvae of the northern anchovy, Engraulis mordax, at 10, 20, 30, and 40 mm SL. The larvae were fed wild zooplankton in high (100 prey/liter) and low (10 prey/liter) concentrations. The 10-mm larvae consumed primarily rotifers, probably because of their past feeding history. The 20-40-mm larvae tended to select large copepods at low concentrations. The ability of late larvae to select the largest prey available is similar to the foraging behavior of adult anchovies reported by previous workers. The foraging of 40-mm larvae was probably restricted by the size of the experimental tanks.

Feeding rates as a function of larval size and prey concentration were estimated and compared to a conservative estimate of basal metabolic costs. Only 20- and 30-mm larvae feeding at 100 prey/liter consumed enough food to grow at rates similar to those observed in the sea, which indicates that even late larvae require somewhat concentrated patches of food.

Sen, A. R. 1986. Methodological problems in sampling commercial rockfish landings. Fish. Bull., U.S. 84(2):409-421.

The present sample survey plan, for the estimation of age and species composition of California rockfish landings, which is stratified two-stage with port-month group as a stratum, poses serious operational problems in data collection. A revised plan is suggested which is workable. Formulas have been developed for estimating total catch and its error by species-sex-age groups; optimum sampling and subsampling fractions have been obtained for a given cost function and the precision of the estimator is compared with two other estimators. The method developed has been extended to cover situations other than rockfish.

The paper also deals with double-sampling for specified cost for the estimation of age composition of a species, which is important to predict the status of a stock in future years, the inherent problems in data collection in commercial fisheries, and the measurement errors involved in the survey.

Suzuki, T., S. Yamamoto, K. Ishii, and W. M. Matsumoto. 1986. On the flying squid Stenotuthis Isid oualaniensis (Lesson) in Hawaiian waters. Bull. Fac. Fish. Hokkaido Univ. 37(2):111-123.

Wolf, Patricia and Paul E. Smith. 1986. The relative magnitude of the 1985 Pacific sardine spawning biomass off southern California. Calif. Coop. Oceanic Fish. Invest. Rep. 27:25-31.

The spawning biomass of the Pacific sardine off southern California during 1985 is considered to be at least 20,000 short tons. This determination was made using an inverse egg production or "egg production area" method, which estimates the area over which a specified spawning biomass (20,000 tons) would be expected to occur. Our survey had a 95% probability of detecting the spawning area within the survey area if at least 20,000 tons of adults were present. This method was developed from the egg production method, which estimates adult biomass from measurements of egg production in the spawning area and from the egg production rate of the adult population. Using estimates of the components of egg production and specific fecundity for sardines from previous studies, we predicted that 20,000 tons of spawning biomass would cover a spawning area of about 500 n.mi².

A total of 86 sardine eggs was collected at 11 of 419 stations during the May 1985 survey, which ranged from San Diego to Point Conception and extended from within one mile of the coast to approximately 80 miles offshore. Spawning occurred mainly along the Santa Barbara/Ventura coast and covered an estimated 670 n.mi². A total of 1,170 anchovy eggs and 266 anchovy larvae were found at 114 and 69 of the stations, respectively.

As provided by state law when the sardine biomass reaches 20,000 tons, a 1,000-ton fishery for sardines was opened on January 1, 1986. This is the first directed fishery allowed for California sardines since a moratorium on sardine fishing was enacted in 1974. Adult reproductive parameters and egg survival must be determined for absolute biomass estimation.

Correction: The following paper was incorrectly cited in the July-August Report of Activities. The correct citation is: Polovina, J. J., R. B. Moffitt, S. Ralston, P. M. Shiota,

and H. A. Williams. 1985. Fisheries resource assessment of the Mariana Archipelago, 1982-85. Mar. Fish. Rev. 47(4):19-25.

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